UGUST 1960
OLUME 3 • NUMBER 8

- Strandberg — Precise Specification of a Frequency
- Hill — Microwave Spectroscopy
- Huard — A Short-Order Construction Technique for Test Antennas
- Baars — Nomograms for Microwave Filter Design

he microwave journal

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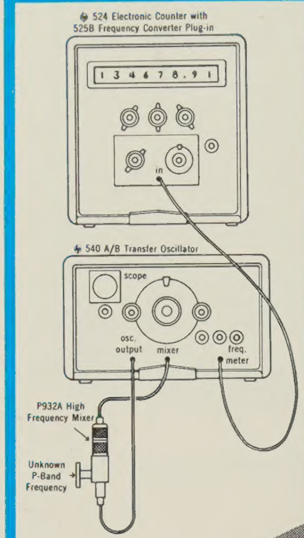
Also In This Issue . . .

THE FERRITE MARKET

MEASURE FREQUENCIES TO 18 KMC

with counter accuracy


hp 524 Electronic Counter with 525B Frequency Converter Plug-in
1 3 4 6 7 8 . 9 1
in
hp 540 A/B Transfer Oscillator
scope
osc. output
mixer
freq. meter
P932A High Frequency Mixer
Unknown P-Band Frequency

New fixed tuned hp harmonic mixers offer "low frequency" measuring ease and accuracy, have high sensitivity, obviate tuning delays.

12.4 to 18 KMC P-Band *New hp P932A Harmonic Mixer* mounts directly in your waveguide system and operates with an hp 540A or 540B Transfer Oscillator, as indicated in the block diagram. The 540 Oscillator output is applied directly to the mixer, which generates harmonics and mixes them with the unknown waveguide frequency. The mixer's beat frequency output is applied to the 540's oscilloscope, the oscillator tuned for zero beat scope indication, and the oscillator frequency setting noted. Simple multiplication of the 540 dial frequency by the harmonic number yields the unknown to within 0.5%. Measuring the oscillator frequency on an hp 524 series counter increases accuracy of measurement on clean cw signals up to 1 part in 10^7.

hp P932A maximum input power is 100 mw, minimum video output is 0.1 mv rms with 0 dbm input, output impedance 1000 ohms with 35 $\mu\mu$f shunt, sensitivity approximately —10 dbm. $250.00.

5 to 12.4 KMC New hp 934A Harmonic Mixer operates from 2 to 12.4 KMC, extends the range of the hp 540A Transfer Oscillator from 5 KMC to 12.4 KMC and offers the same advantages as the P932A, including the fixed tuned feature eliminating tedious adjustment. Maximum input power is 100 mw, typical sensitivity is —45 dbm at mid-range points, minimum video output is 0.5 mv rms (0 dbm input) and output impedance is the same as hp P932A. Model 934A $150.00.

220 MC to 5 KMC or 12.4 KMC Hewlett-Packard 540 Transfer Oscillators (see diagram) extend the range of the hp 524 series counters to 5 KMC (hp 540A) and 12.4 KMC (hp 540B), making possible frequency measurements with counter accuracy well into the microwave region. These oscillators also measure carrier frequency of pulses, determine carrier frequency and deviation of FM signals, and measure frequency accurately despite high noise. hp 540A, $615.00. hp 540B, $750.00. (Rack mount models $15.00 less.)

FREQUENCY MEASUREMENT

FREQUENCY RANGE	EQUIPMENT	TOTAL* PRICE
0 - 10 MC	524C or 524D Frequency Counter	$2,150.00
10 - 100 MC	524C/D + 525A Converter (0-10 MC) (10-100 MC)	$2,400.00
100 - 220 MC	524C/D + 525B Converter (0-10 MC) (100-220 MC)	$2,400.00
220 MC - 5 KMC	524C/D + 525B + 540A Transfer Oscillator (0-10 MC) (100-220 MC) (220 MC - 5 KMC)	$3,015.00
220 MC - 12.4 KMC	524C/D + 525B + 540A +934A Harmonic Mixer (0-10 MC) (100-220 MC) (220 MC-5 KMC) (2-12.4 KMC) -or- 524C/D + 525B 540B Transfer Oscillator (0-10 MC) (100-220 MC) (220 MC-12.4 KMC)	$3,165.00 $3,150.00
12.4 - 18 KMC	524C/D + 525B + 540A + P932A Harmonic Mixer (0-10 MC) (100-220 MC) (220 MC - 5 KMC) (12.4 - 18 KMC) -or- 524C/D + 525B + 540B + P932A (0-10 MC) (100-220 MC) (220 MC-12.4 KMC) (12.4 - 18 KMC)	$3,265.00** $3,400.00

*Based on 524D Frequency Counter $2,150.00. 524C price $2,300.00. Counter and Transfer Oscillator prices are for cabinet mounts; rack mounts are slightly lower.
**If coverage 5-12.4 KMC is desired, add 934A, $150.00.

Data subject to change without notice. Prices f.o.b. factory.

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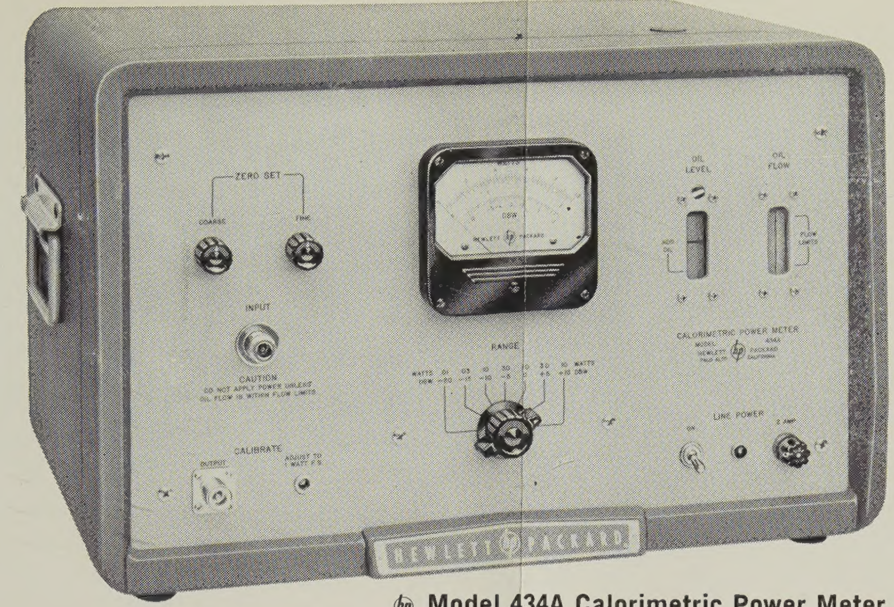


hp **Model 434A Calorimetric Power Meter**

Fastest, easiest way yet devised to MEASURE POWER 10 MW TO

without external terminations or

Now you can quickly and confidently measure power to 10 watts average, 1 Kw peak! With the hp Model 434A, simply connect power to be measured to the 50-ohm type N front-panel coaxial connector . . . and read power directly in watts and DBW.

This precision instrument fills the important range between bolometer type microwave power meters (such as the popular hp 430C) and conventional calorimeters whose lower range is approximately 10 watts. The 434A is useful for measuring AM power, pulsed power, cw power and dc power.

Just two operating controls, range switch and zero set. No other adjustments are necessary to make power measurements at any frequency, dc to 12.4 KMC. The 434A requires no barretter, thermistor or external power termination. Directional couplers or similar external equipment can be used to extend the 434A power range above 10 watts. An internal calibrator assures that the 434A is always operating at peak performance.

Rapid response time—high stability

The 434A contains a self-balancing bridge and high-efficiency heat transfer system using an oil stream to provide a full scale response time of 5 seconds or less. This fast response, a fraction of the response time of ordinary calorimeters, means the 434A quickly follows small adjustments in input tuning circuits. A new high in stability is achieved through the use of twin power-sensitive elements immersed in a single oil stream, making the 434A independent of variations in oil flow rate and temperature.

Operating in 7 meter ranges, the Model 434A has a specified accuracy of ± 5% of full scale. Even greater accuracy is achievable through appropriate techniques. Typical techniques are briefly described in the hp Journal, Volume 9 Number 12, August 1958.

World leader in precision test instrumentation

Just connect, then read power

Direct reading in watts, DBW

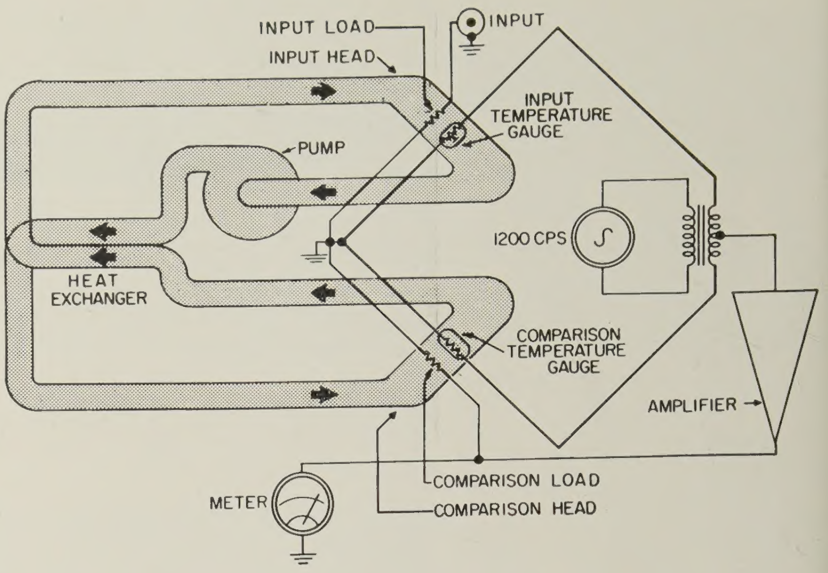
Only two operating controls

Measure cw or pulsed power

Compact, self-contained

Fast reading – 5 sec. response maximum

Internal 1% calibrator



10 WATTS, DC TO 12.4 KMC

equipment

SPECIFICATIONS

Input power range: Seven meter ranges. Full-scale readings of 0.01, 0.03, 0.1, 0.3, 1.0, 3.0 and 10 watts. Meter scale also calibrated from —10 to 0 DBW, providing continuous readings from —30 to +10 DBW. Power range can be extended upward with attenuators or directional couplers.

Peak input power: 1 kilowatt, maximum

Frequency range: Dc to 12.4 KMC

Dc input impedance: 50 ohms ± 5 ohms at type N input jack

Input VSWR: Dc to 5 KMC, less than 1.3. 5 to 10 KMC, less than 1.5. 10 to 12.4 KMC, less than 1.7.

Meter response time: Less than 5 seconds for full scale deflection.

Accuracy: Within ± 5% of full scale. Includes dc calibration and termination efficiency, but not mismatch loss. Greater accuracy can be achieved through appropriate techniques.

Power supply: 115/230 volts ± 10%, 50/60 cycles, approximately 155 watts with no input. 175 watts with 10 watts input.

Price: Model 434A (cabinet), $1,400.00; Model 434AR (rack mount), $1,385.00.

Data subject to change without notice.
Prices f.o.b. factory.

Circuitry Basically, the hp Model 434A consists of a self-balancing bridge which has identical temperature-sensitive resistors (gauges) in two legs, an indicating meter and two load resistors, one for the unknown input power and one for the comparison power. The input load resistor and one gauge are in close thermal proximity so that heat generated in the input load resistor heats the gauge and unbalances the bridge. The unbalance signal is amplified and applied to the comparison load resistor which is in close thermal proximity to the other gauge, so that the heat generated in the comparison load resistor is transferred to its gauge and rebalances the bridge.

The meter measures the power supplied to the comparison load to rebalance the bridge. Characteristics of the gauges are the same and heat transfer characteristics from each load are the same, so the power dissipated in each load is the same, and the meter may be calibrated directly in input power.

The power measurement is accurate, because the flow rate through the input head and comparison head (see diagram) is the same and the oil enters the heads at nearly the same temperature. To insure constant temperature and to bring the streams to nearly the same temperature, they are passed through a parallel-flow heat exchanger just prior to entering the heads. Identical flow rates are obtained by placing all elements of the oil system in series.

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6359

Detecting The Invisible Half of Matter

An overwhelming percentage of space is a relative void, but drifting in that void are vast seas of rarified material, known as the interstellar medium. The amount of material in the interstellar medium is comparable with the total mass of the stars and is composed primarily of gas and dust. Giant radio telescopes, combined with the most sensitive radio devices ever constructed, are probing the interstellar medium. In this manner, radio astronomers seek answers for some of the most provocative questions posed by science.

Because interstellar space is so very cold, the major portions of the interstellar medium are optically invisible. For the most part, the presence of the medium can be detected only by radio astronomical techniques which are capable of measuring the minute amount of radio energy generated in space. Spectral line radiation from the interstellar medium is the most profitable area of study.

The gas which has been the main research objective is atomic hydrogen. A hyperfine transition in the ground state of the hydrogen atom occurs at a frequency of 1420.40572 ±0.00001 Mc. Around the Milky Way, the hydrogen line appears in emission. In the direction of discrete sources (radio stars) the line is reversed and appears in absorption. Signal powers produced by this radiation at the terminals of an antenna are usually of the order of 10^{-18} watts; therefore, extremely high receiver sensitivities are required for research programs.

The study of this radiation is being vigorously pursued at the major astronomical observatories of the world. Objectives of the research programs include a measurement of the mass of the Milky Way, measuring the distance from the earth to the sun, determining distances to radio stars, mapping the spiral arms of the Milky Way, measuring the interstellar magnetic field, and measuring the gas content of island universes at very remote cosmic distances. A precise determination of a hydrogen line profile is critical for all these research programs. To accomplish this determination, a radiometric system must be extremely stable, ultra-sensitive, retain "flat" critical RF parameters while scanning, and operate reliably and dependably.

The development and manufacture of receiving systems meeting requirements such as those described above has been Ewen Knight's major activity for a decade. Ewen Knight radiometric systems are in daily operation at the leading radio astronomy laboratories in the Americas. Other systems, destined for giant radio telescopes now under construction in the United States, are now taking form at Ewen Knight. Similar receivers are being developed for missile trackers and radiometric navigation systems. Our staff, accustomed to "frontier" demands, stands ready to translate your most complex solid state or conventional microwave system requirements into reliable instrumentation.

Ewen Knight CORPORATION

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AUGUST, '60 vol.3 - no.8

the microwave journal

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The Traveling Wave Resonator and High Power Microwave Testing

Calculation of Microwave Antenna Radiation Patterns by the Fourier Integration Method

Detection and Measurement of Spurious Signals Generated by Microwave Oscillator Tubes

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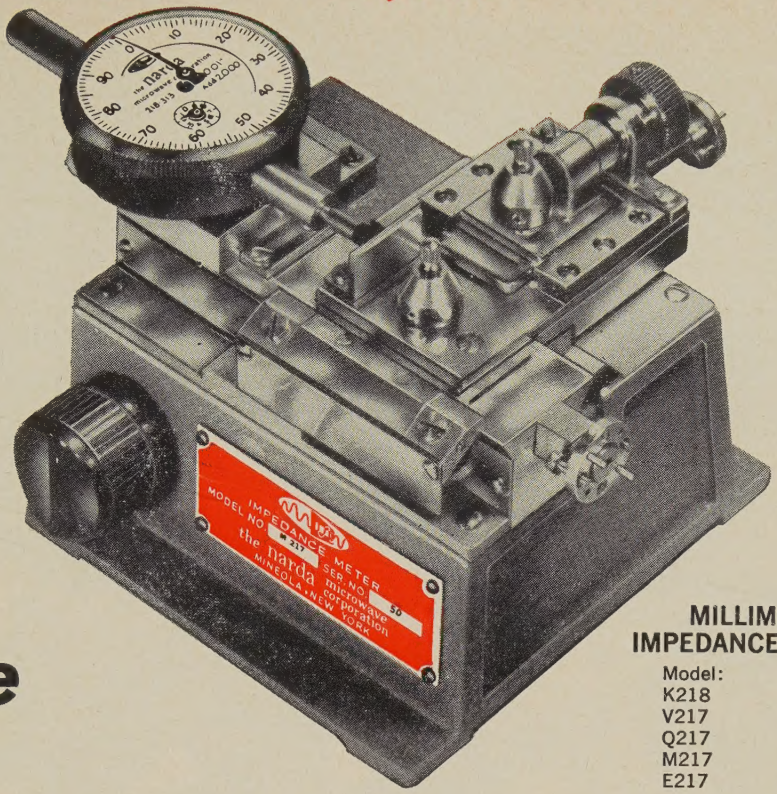

MILLIMETER IMPEDANCE METERS

Model:	Price:
K218	$ 500.
V217	600.
Q217	1100.
M217	995.
E217	1650.

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eason to "make do" with lesser specs than you
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efits: Smooth, stable carriage travel, absolutely
allel to the transmission line axis, with complete
dom from backlash. Imperceptible slope (0.01
.), thanks to precision milling of tellurium copper main transmission line, followed by a silver plate of molecular thickness and a rhodium flash.

Residual VSWR is under 1.01 for K and V Bands; 1.02 for Q, M and E. Position of the built-in probe is measured with a precision dial indicator having a least count of 0.001″. And as an added advantage, the probe is usable with any waveguide detector.

All in all, an exceptionally fine instrument — and yet, typical of all Narda millimeter products. For complete information on the entire line, write for a free catalog. Address: Dept. MJ-6.

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From idea exploitation in the laboratory, to prototype engineering, to quantity production and assembly, you can look with confidence to the team capability of Gorham Electronics and Pickard & Burns Inc. For example, in microwave antenna systems, these integrated services are available for Airborne, Shipboard and Surface installations including the antenna, mount, pedestal, drive, servos, feeds and all associated microwave devices. Gorham Electronics is geared to accomplish the most difficult assignments currently challenging industry and government.

If the scope of your operations span ANTENNA SYSTEMS, MICROWAVE DEVICES, SLIP RINGS AND ELECTRO-MECHANICAL DEVICES, send for this comprehensive brochure, or write, wire or phone to have our representatives discuss your problems first hand.

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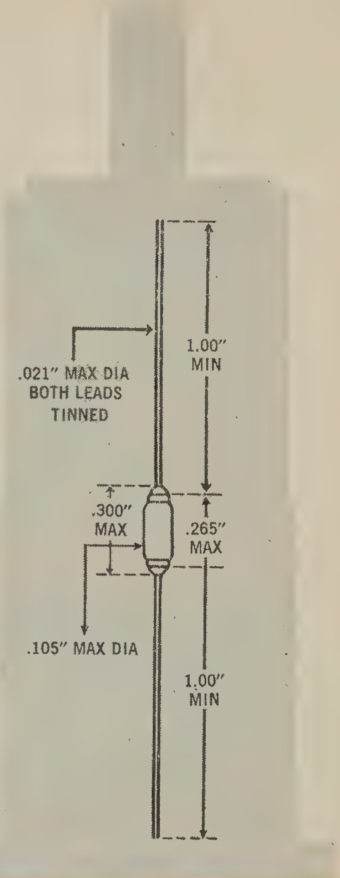
90% smaller in volume and weight...

Sylvania Micro-Min Diodes shown actual size.



SYLVANIA
ICRO-MIN DIODES

offer microminiaturization in microwave circuitry

-tenth the size, one-tenth the weight—*90% smaller than their otypes*—Sylvania *Micro-Min* Diodes extend design possibili- where microminiaturization and reliability are essential to rowave equipment.

vania *Micro-Min* mixer and detector diodes feature true metic seals . . . withstand temperatures of −55°C to +150°C meet MIL-S-19500B environmental specs for shock, vibra-, lead fatigue, acceleration, moisture resistance, soldering temperature cycling.

v packages—*even smaller than Micro-Min Diodes*—are now under devel-nent at Sylvania! Our engineers can work with you in eloping new microminiaturized equipment. Contact them.

our present design requirements are for exceptionally small, extremely lightweight *and* maximum reliability, specify vania Microwave *Micro-Min* Diodes. For price and delivery ormation, contact your Sylvania Field Office or your local nchised Sylvania Semiconductor Distributor. For technical a on specific Sylvania *Micro-Min* Diodes, write Semiconductor ision, Sylvania Electric Products Inc., Dept. 187, Woburn, ssachusetts.

MICRO-MIN TYPE	APPLICATION	PROTOTYPE
1N830	UHF Detector	—
1N830A	UHF Detector	—
1N831*	S Band Mixer	1N21C*
1N831A*	S Band Mixer	1N21E*
1N832*	X Band Mixer	1N23C*
1N833	X Band Video Detector	1N358
1N918	Ku Band Mixer	1N78

*Available in Matched Pairs

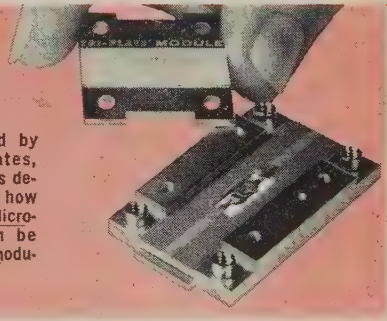


Photo shows Sylvania Micro-Min Diode as used in TRI-PLATE® detector module designed by Sanders Associates, Nashua, N. H. This device illustrates how easily Sylvania Micro-Min Diodes can be integrated into a modular construction.

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MICROVIEWS

OF THE MONTH

45 ▶ **PRECISE SPECIFICATION OF A FREQUENCY**

M. W. P. Strandberg

A discussion is presented of the actual characteristics of the klystron from the point of view of frequency — where the output power of the device is not in fact at a single frequency, but covers a spectrum. Means of taking a realistic look at this output are presented.

51 ▶ **MICROWAVE SPECTROSCOPY**

Robert M. Hill

This paper reviews the application of microwave techniques to the study of atomic and molecular structure, and looks ahead to future possibilities of investigations by this modern means.

55 ▶ **A SHORT ORDER CONSTRUCTION TECHNIQUE FOR TEST ANTENNAS**

George R. Huard, Jr.

When it is necessary to evaluate an antenna design in the shortest possible time, constructing a suitable experimental model can be too laborious and time consuming. This paper describes a simple method of constructing test models of reflector type antennas by the use of the tooling plaster technique. The process emphasizes ease and speed of fabrication. Because of the simplicity of this method, relatively small size reflectors can be constructed in 3 days or less.

59 ▶ **NOMOGRAMS FOR MICROWAVE FILTER DESIGN**

Reinhard D. Baars

Here are presented nomograms consolidating the parameters bandwidth, rejection, insertion loss, frequency, and unloaded Q, which are of primary interest to the designer of filters at microwave frequencies.

OUR COVER

A completed "short-order" test antenna with base and antenna feed mechanism, and one of the steps in process of construction of this useful device. For detailed description, see page 55.

LOWEST NOISE* POWER KLYSTRONS FOR CW RADAR AND ILLUMINATORS

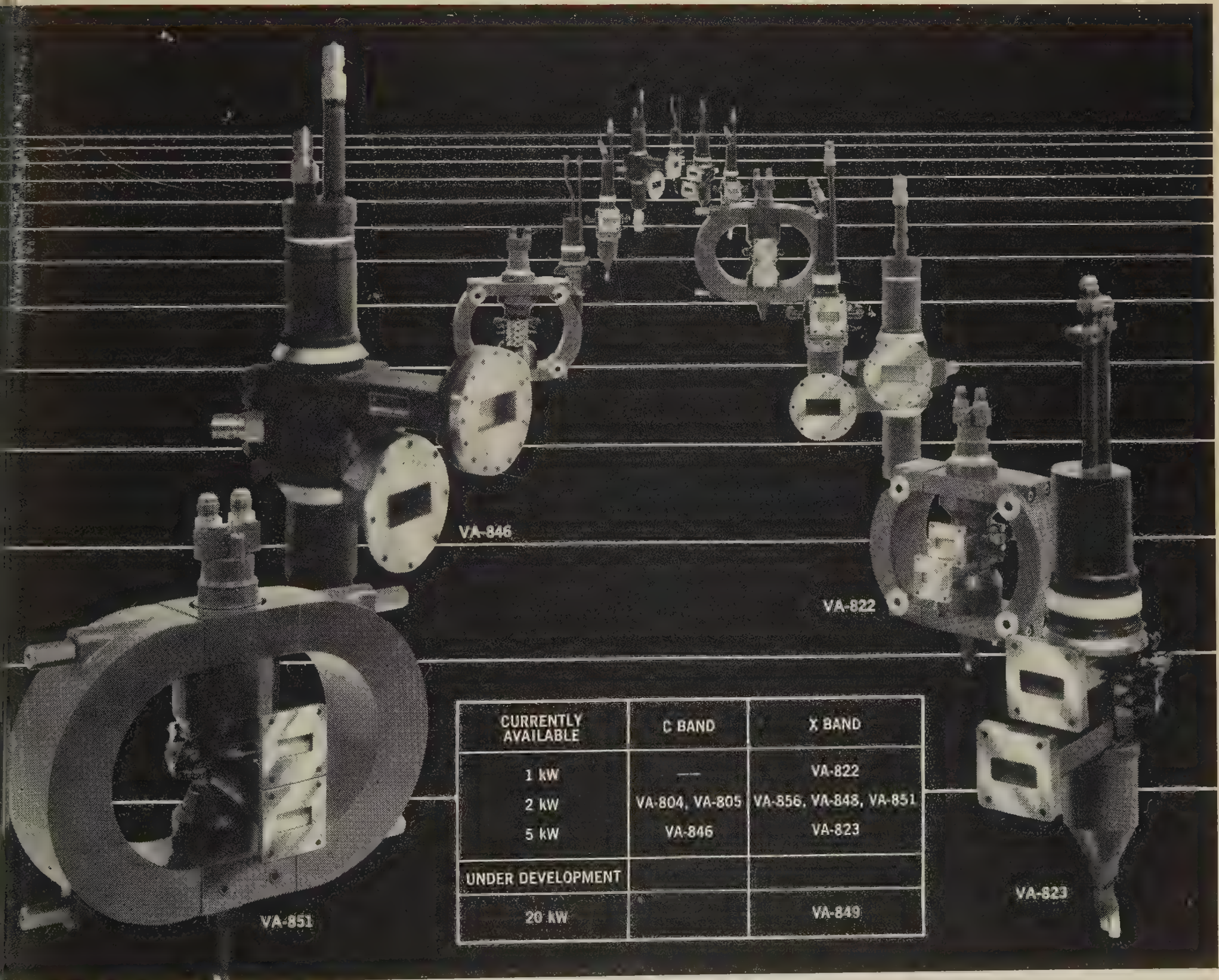
- 1 to 5 kilowatts CW power
- 50 db gain (most types)
- Efficiency up to 45%
- Noise 100 db below carrier*
- C and X band frequencies
- Focusing by electromagnet or permanent magnet

**AM and FM noise is more than 100 db below carrier in any 1 kc channel more than 1 kc removed from the carrier.*

Varian is delivering many high-power low-noise CW klystrons for CW radar and illuminators; eight types are unclassified and are listed below. A 20 kilowatt X band type, soon to be added, will be another extension of the state-of-the-art by Varian.

Because of their extremely low noise close to the carrier, these types will enable you to design radar and illuminator systems of great sensitivity and precision. They also afford new design opportunities in radio astronomy and communications systems.

May we send full specifications or discuss development of special types for your requirements?



CURRENTLY AVAILABLE	C BAND	X BAND
1 kW	—	VA-822
2 kW	VA-804, VA-805	VA-856, VA-848, VA-851
5 kW	VA-846	VA-823
UNDER DEVELOPMENT		
20 kW		VA-849

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Performance Factor (x 10^9)	4.0	7.0	20.0	40.0
Peak Power Output megawatts	1.0	3.50	12.50	33.0
Forward Anode Voltage Kilovolts	10.0	20.0	25.0	33.0
Peak Anode Current Amperes	200	350	1000	2000
Average Anode Current Amperes	.200	.300	1.5	4.0
Height – Inches	2.25	3.00	5.75	11.0
Diameter – Inches	1.37	1.75	3.00	4.50

For full technical information, circle Reader Card.

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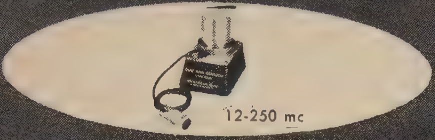
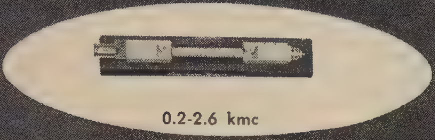
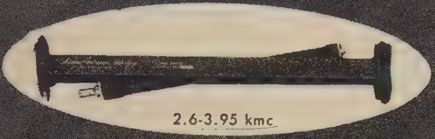
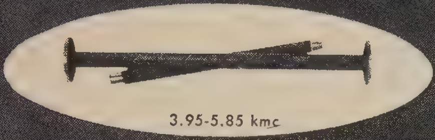
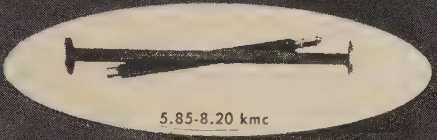
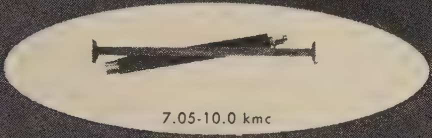

12-250 mc

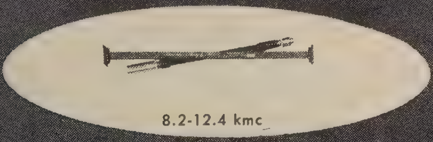

0.2-2.6 kmc

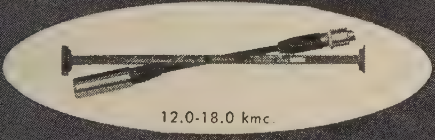

2.6-3.95 kmc

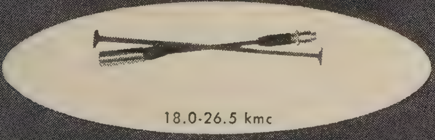

3.95-5.85 kmc

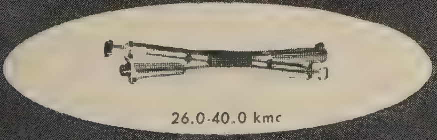

5.85-8.20 kmc


7.05-10.0 kmc


8.2-12.4 kmc


12.0-18.0 kmc


18.0-26.5 kmc


26.0-40.0 kmc

Noise Generators

For Precise Measurement of Noise Figure at all frequencies from 12 mc to 40 kmc.

The AIL Type 70 Series of Noise Generators provide:

- *Most complete frequency coverage available*
- *Secondary standard of relative excess noise temperature*
- *Useful for both automatic and manual measurements*

Broad Selection

- *Eight waveguide units covering 2.6 to 40 kmc*
- *One coaxial unit covering 0.2 to 2.6 kmc*
- *Two Diode Units each covering 12 to 250 mc*
- *Relative excess noise temperature: 15.3 db*
- *Accuracy: ±0.25 db: 50 ohm output*
- *Hot-Cold Body Standard available*

All gas discharge types utilize an argon tube and have an output of 15.28 ±0.25 db.

Maximum Usability . . . As your frequency requirements vary, your high standard of quality control may be maintained by merely adding to your selection of AIL Type 70 Noise Generators to cover the additional ranges. This is possible because of the common power and connector requirements on all models.

With the exception of the Type 70 Hot-Cold Body Standard Noise Generator, all models may be powered by the Type 74 Automatic Noise Figure Indicator for continuous automatic measurements or by the Type 71 Power Supply for manual measurements.

Write for complete descriptive literature.

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DEER PARK, LONG ISLAND, NEW YORK

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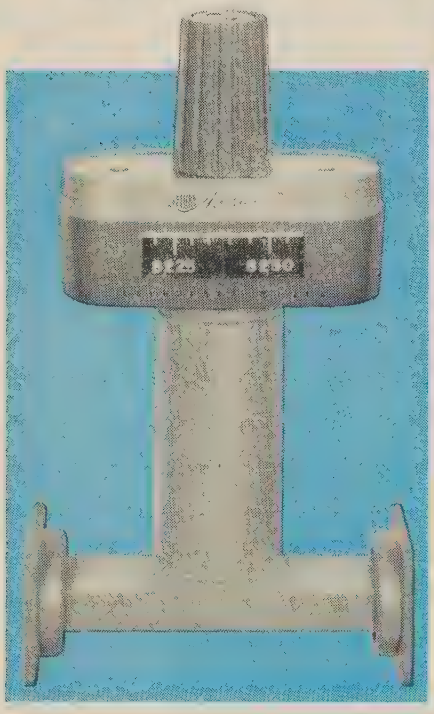
Circle Reader Service Card 6

For direct reading frequency measurements

SPERRY Microline®

FREQUENCY METERS



Try the smoothest broadband direct reading frequency meter available anywhere. Now you can make high accuracy measurements easily and with confidence – made possible through Sperry's unique steel tape readout. Misinterpretation is eliminated and high resolution is achieved by use of tapes whose scale length is 80 inches minimum for any model.

Model	Accuracy	Frequency Range* kmc	Price
12S1	.08%	2.60-3.95	$450.
12C1	.08%	3.95-5.85	250.
12X1	.08%	8.2-12.4	150.
12U1	.1%	12.4-18.0	210.
12K1	.1%	18.0-26.5	230.

*standard waveguide sizes

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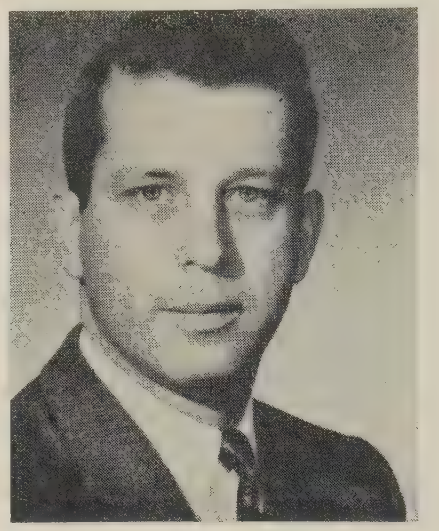
SPERRY 50 YEARS

SPERRY MICROWAVE ELECTRONICS COMPANY,
Clearwater, Fla., Division of Sperry Rand Corp.

◆ Circle Reader Service Card 9

INDUSTRY NEWS

COHN JOINS RANTEC IN TOP TECHNICAL POST



Dr. Seymour Cohn, formerly head of Stanford Research Institute's Electromagnetics Laboratory, has joined the Rantec Corporation, Calabasas, Calif., as vice president and technical director, according to President Robert Krausz.

Cohn succeeds Dr. Robert S. Elliott, now a professor at UCLA, who will remain with the company on a consultant basis.

Well-known for his research and authorship on microwave components and circuits, antennas and microwave systems, Cohn will extend the company's capability in the areas of filters, multiplexers and parametric amplifiers.

Cohn, 1954 recipient of the annual award for the Advancement of Basic and Applied Science given by the Yale Engineering Association, is a fellow of the IRE, and holds over twenty patents. He has more than thirty published technical papers and has been very active on IRE committees. Dr. Cohn is an associate editor of the *microwave journal.*

—*mwj*—

ELKORT IS NEW NARDA MICROWAVE ENGINEER

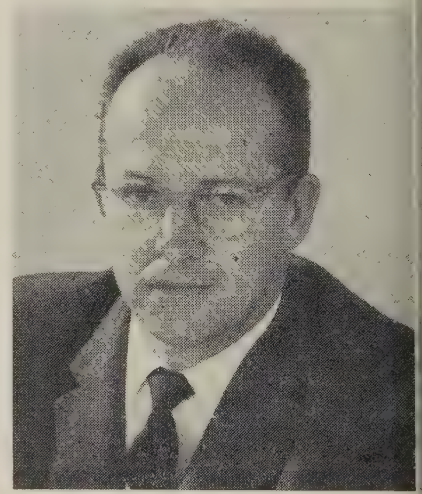
Donald S. Elkort has joined Narda Microwave Corporation, Mineola, L.I., as a microwave engineer and will be responsible for the design and development of microwave ferrite devices, according to an announcement by Stuart Casper, vice president for Engineering.

Mr. Elkort, who was formerly an associate project engineer with the Microwave Electronics Division of Sperry Gyroscope Co., brings to Narda experience in research and development of micr wave ferrite components for high pow radar and countermeasures systems, bot ground and airborne. At Sperry he wa responsible for the design and develo ment of microwave ferrite devices suc as isolators, attenuators and phase shif ers. His previous microwave experien also includes the design of stripline an coaxial line components for use in aut matic test equipment, and the desig and development of components for u in extremely high power, high resol tion, pulse compression radar systems.

Mr. Elkort, who received his BA i physics from New York University, is member of the IRE and its Profession Group on Microwave Theory and Tec niques, and of the American Physic Society.

—*mwj*—

VARIAN PRESIDENT RECEIVES HONORARY DEGREE



H. Myrl Stearns, president of Varia Associates, Palo Alto, Calif., received a honorary Doctor of Science degree at sp cial ceremonies at the 65th commenc ment exercises of the University of Idah Moscow, Idaho.

Ernest K. Lindley, director of th Washington, D.C. bureau of *Newswee* Magazine, received an honorary Doct of Literature degree at the same cer mony and presented the Commencemen address.

Mr. Stearns joined Russell and Sigur Varian, the inventors of the klystro tube, and other scientists in foundin Varian Associates in 1948. He served a executive vice president and general ma ager of the electronics firm from i founding until June 1957 when he w named president.

Under the administrative direction Mr. Stearns, the late Russell Varian, an their associates, the firm has grown fro

il company with capital assets of
00 and a total staff, including offi-
nd employees, of six to a diversi-
orporation with five subsidiary com-
and anticipated sales of $50 mil-
or the current fiscal year.
Stearns received his BS degree
the University of Idaho in 1937.
graduation he went to Stanford
rsity and served as a teaching and
ch assistant while studying for his
ced degree in electrical engineering
he received in 1939.
1941 he joined Sperry Gyroscope
ater headed that company's Doppler
program. In 1946 he received a
endation from the secretary of the
for work on radar in connection
submarine warfare and leadership
war effort at Sperry.
. Stearns holds patents in the fields
tomatic frequency control and auto-
ranging and is the author of tech-
research papers in the fields of
, microwave tubes and engineering
gement. He is a past president of
Western Electronics Manufacturers
iation, a fellow of the IRE, a fel-
f the American Association for the
ncement of Science and a member
gma Xi and Sigma Tau, scientific
ngineering honorary societies.

— *mwj* —

GENDRE JOINS DU MONT RATORIES TUBE DIVISION AS ECHNICAL ASSISTANT TO MANAGER

e appointment of Victor Le Gendre
hnical assistant to the division man-
for the Electronic Tube Division of
B. Du Mont Laboratories, Inc., Clif-
N.J., is announced by Joseph P.
on, general manager for the Divi-
Mr. Le Gendre will carry out spe-
managerial assignments in research
production for industrial cathode-
ubes, storage tubes, multiplier photo-
and microwave tubes. His initial
ct will be the administration of an
nsion program for direct-view stor-
ube production reporting to Dr. Al-
E. Beckers, director of Research and
neering, to fulfill demand and sales
ese Du Mont products.
r. Le Gendre comes to Du Mont
the post of chief engineer of stor-
athode-ray tubes at the International
phone and Telegraph Co. Compo-
s Division. He is a leading tube scien-
nd engineering administrator, having
d prior to IT&T as chief engineer
e Electronic Tube Division of Bur-
h Corp. Prior posts were with
ham Electronics, National Union
ric, Tung-Sol and Western Electric.
Le Gendre has bachelors' degrees in
as well as sciences and philosophy
was a professor in physics and chem-
at Canadian colleges. He has been
ted electronic tube patents and is
mber of the IRE.

— *mwj* —

(*Continued on page 16*)

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29A1 SWR Indicator

IMMEDIATE DELIVERY **$200**

Many features designed into the 29A1 are not normally included at such a low price. And it is available for immediate delivery.

Adjustable bandwidth allows maximum sensitivity with freedom from modulator drift errors. Positive protection against bolometer burnout. Expanded scale with automatic gain compensation. Push-to-read bolometer current. Plus 5 db gain supplement always assures accurate upscale meter readings. Designed for ease of operation.

Frequency:	1000 cps ± 1%
Sensitivity:	0.1 uv for full scale deflection
Noise Level:	Less than 0.03 uv at min. bandwidth
Bandwidth:	Wide Band: 300-5000 cps Narrow Band: continuously adjustable 30-150 cps
Range:	70 db adjustable in 5 db steps accurate to ± .1 db per step
Recorder Output:	0 to 1 ma, 1500 ohms, one side grounded
Dimensions:	Approx. 8″ x 11″ x 12″

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SPERRY 50 YEARS 1910-1960

SPERRY MICROWAVE ELECTRONICS COMPANY, Clearwater, Florida, Division of Sperry Rand Corporation

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MATHMANSHIP

By

NICHOLAS VANSERG

In an article published a few years ago, the writer[1] intimated with befitting subtlety that since most concepts of science are relatively simple (once you understand them) any ambitious scientist must, in self protection, prevent his colleagues from discovering that *his* ideas are simple too. So, if he can write his published contributions obscurely and uninterestingly enough no one will attempt to read them but all will instead genuflect in awe before such erudition.

What Is Mathmanship?

Above and beyond the now-familiar recourse of writing in some language that looks like English but isn't, such as Geologese, Biologese, or, perhaps most successful of all, Educationalese[2], is the further refinement of writing everything possible in mathematical symbols. This has but one disadvantage, namely, that some designing skunk equally proficient in this low form of cunning may be able to follow the reasoning and discover its hidden simplicity. Fortunately, however, any such nefarious design can be thwarted by a modification of the well-known art of gamesmanship[3].

The object of this technique which may, by analogy, be termed "Mathmanship" is to place unsuspected obstacles in the way of the pursuer until he is obliged by a series of delays and frustrations to give up the chase and concede his mental inferiority to the author.

The Typographical Trick

One of the more rudimentary practices of mathmanship is to slip in the wrong letter, say a y for a r. Even placing an exponent on the wrong side of the bracket will also do wonders. This subterfuge, while admittedly an infraction of the ground rules, rarely incurs a penalty as it can always be blamed on the printer. In fact the author need not stoop to it himself as any copyist will gladly enter into the spirit of the occasion and cooperate voluntarily. You need only be trusting and not read the proof.

Strategy of the Secret Symbol

But, if by some mischance, the equations don't get badly garbled, the mathematics is apt to be all too easy to follow, *provided* the reader knows what the letters stand for. Here then is your firm line of defense: at all cost *prevent him from finding out!*

Thus you may state in fine print in a footnote on page 35 that V^x is the total volume of a phase and then on page 873 introduce V^x out of a clear sky. This, you see, is not actually cheating because after all, or rather before you *did* tell what the symbol meant. By surreptitiou introducing one by one all the letters of the Engli Greek and German alphabets right side up and upsi down, you can make the reader, when he wants to lo up any topic, read the book backward in order to find what they mean. Some of the most impressive books re about as well backward as forward, anyway.

But should reading backward become so normal as be considered straightforward you can always double ba on the hounds. For example, introduce μ on page 66 a avoid defining μ until page 86.[1] This will make whole book required reading.

The Pi-throwing Contest or Humpty-Dumpty Dodge

Although your reader may eventually catch up w you, you can throw him off the scent temporarily by ma ing him *think* he knows what the letters mean. For ample every schoolboy knows what π stands for so y can hold him at bay by heaving some entirely differ kind of π into the equation. The poor fellow will au matically multiply by 3.1416, then begin wondering h a π got into the act anyhow, and finally discover that the while π was osmotic pressure. If you are careful to warn him, this one is good for a delay of about an ho and a half.

This principle, conveniently termed pi-throwing can, course, be modified to apply to any other letter. Thus y can state perfectly truthfully on page 141 that F is f energy so if Gentle Reader has read another book th used F for *Helmholtz* free energy he will waste a lot his own free energy trying to reconcile your equatio before he thinks to look for the footnote tucked away the bottom of page 50, dutifully explaining that what y are talking about all the time is *Gibbs* free energy wh he always thought was G. Meanwhile you can co pound his confusion by using G for something else, su as "any extensive property." F, however, is a particula happy letter as it can be used not only for any unspecif brand of free energy but also for fluorine, force, fricti Faradays, or a function of something or other, thus creasing the degree of randomness, dS. (S, as everyo knows stands for entropy, or maybe sulfur). The conte of course, will make the meaning clear, especially if y can contrive to use several kinds of F's or S's in the sa equation.

For all such switching of letters on the reader you unimpeachable authority by paraphrasing the writing n eminent mathematician[4]:

---

* Reprinted from "American Scientist," Vol. 46, June 1958.

[1] All these examples are from published literature. Read desiring specific references may send a self-addressed stam envelope. I collect uncanceled stamps. — N. Vanserg

> When I use a letter it means just what I choose it to mean ither more nor less . . . the question is, which is to be er — that's all."

Unconsummated Asterisk

peaking of footnotes (I was, don't you remember?) a le ruse is the "unconsummated asterisk" or "ill-starred r." You can use P* to represent some pressure dif- nce from P, thus tricking the innocent reader into ing at the bottom of the page for a footnote. There any, of course, but by the time he has decided that ust be some registered trademark as in the magazine ertisements he has lost his place and has to start over n. Sometimes, just for variety, you can use instead of asterisk a heavy round dot or bar over certain letters. doing so, it is permissible to give the reader enough ed hints to make him *think* he can figure out the sys- but do not at any one place explain the general idea his mystic notation, which must remain a closely guard- secret known only to the initiated. Do not disclose it er pain of expulsion from the fraternity. Let the led Barbarian beat his head against the wall of mystery. may be bloodied, but if it is unbowed you lose the id.

he other side of the asterisk gambit is to use a super- pt as a key to a *real* footnote. The knowledge-seeker s that S is -36.7^{14} calories and thinks "Gee what a whale of a lot of calories" until he reads to the bottom of the page, finds footnote 14 and says "oh."

The "Hence" Gambit

But after all, the most successful device in mathmanship is to leave out one or two pages of calculations and for them substitute the word "hence" followed by a colon. This is guaranteed to hold the reader for a couple of days figuring out how you got hither from hence. Even more effective is to use "obviously" instead of "hence," since no reader is likely to show his ignorance by seeking help in elucidating anything that is obvious. This succeeds not only in frustrating him but also in bringing him down with an inferiority complex, one of the prime desiderata of the art.

These, of course, are only the most common and elementary rules. The writer has in progress a two-volume work on mathmanship complete with examples and exercises. It will contain so many secret symbols, cryptic codes and hence-gambits that no one (but no one) will be able to read it.

References

1. Vanserg, Nicholas. How to write Geologese, **Economic Geology**, Vol. 47, pp. 220-223, 1952.
2. Carberry, Josiah. **Psychoceramics,** p. 1167, Brown University Press, 1945.
3. Potter, Stephen. Theory and Practice of Gamesmanship or the Art of Winning Games without Actually Cheating. London: R. Hart-Davis, 1947.
4. Carroll, Lewis. Complete Works, Modern Library edition p. 214.

April fool. See what I mean?

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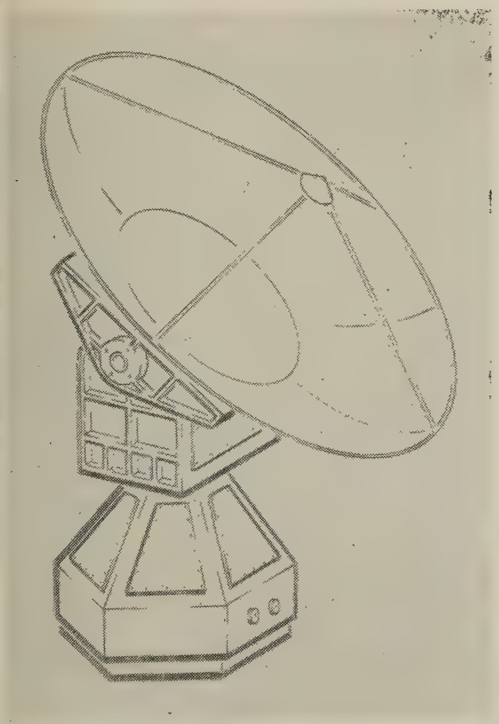

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directly, continuousl
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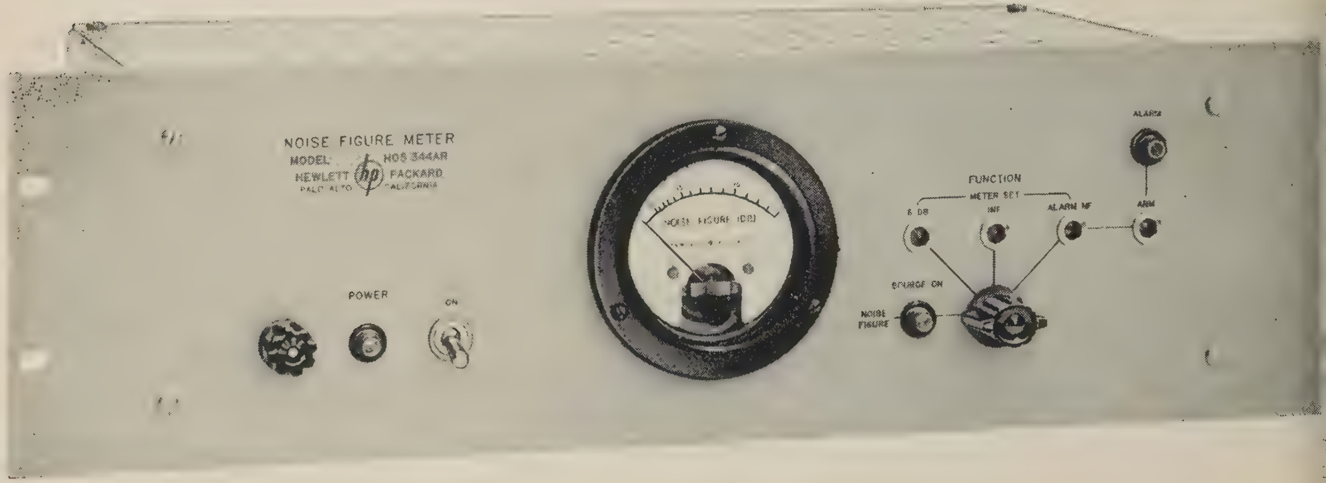
All-New, Transistorized hp® 344AR Noise Figure Mete



The new hp 344AR Noise Figure Meter assures you that your radar is continuously operating at peak performance, and you are enjoying maximum range. The instrument's fast meter response lets you optimize or adjust the system during operation or maintenance. Model 344AR is designed for the utmost in dependability—it is militarized, transistorized, very compact and very rugged.

With this new 5¼″ high instrument system noise figure is measured on a time-shared basis with the radar scan. The unit has high sensitivity to minimize signal and transmitter losses; the noise source may be decoupled 20 db from the main transmitter line. Two alarm functions give visible and electrical indication when an allowable noise figure is exceeded, or a noise source malfunctions.

High voltage on antenna slip rings is eliminated with a remote noise source modulator operated with low voltage triggers. Other features include quick, easy front panel calibration, and remote metering and alarms if desired.

FREE APPLICATION NOTES INCLUDE CONSIDERATIONS FOR AUTOMATIC MEASUREMENT OF NOISE FIGURE ON A CONTINUOUS BASIS

Write hp direct for Application Note 43—"Continuous Monitoring of Radar Noise Frequency". Discussion includes description of hp 344AR and its application to radar systems.

Circle Reader Service Card 7

oise figure
nd automatically
adars!

Separate Modulator, Noise Source

e new hp 344AR Noise Figure Meter operates on either 25 or 30 MC IF frequency. It is designed for pulse dars with repetition rates of 90 to 500 pps; also, its gh sensitivity and compact design make it very valuele in all radars, including high PRF and CW Types. its free-run mode it measures receiver noise figure thout turning on the transmitter or radar timing circitry. Thus periodic measurement and maintenance ocedures are simplified.

e 344AR's noise source and modulator are separate its which may be mounted on the antenna mast or an aircraft. In the first case, high voltage connections short and beyond slip rings. In the second case, you ve weight and space and measure noise figure on the ound through low voltage connections.

Operation

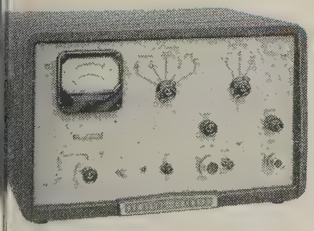
e hp 344AR measures noise figure by operating a andard noise source and comparing the noise output equipment under test when the noise source is off the noise output when the noise source is on. Since e hp 344AR measures in synchronism with the radar, e noise source and measuring circuitry are triggered a pulse from the radar's timing circuit, occurring at e end of the radar scan.

SPECIFICATIONS

hp 344AR Noise Figure Meter

Input Frequency:	25 or 30 MC, as specified
Bandwidth:	1 MC
Input Sensitivity:	Requires 35 db ± 5 db gain between noise source and 344AR input
Input Impedance:	75 ohms nominal. Passive termination during radar scan
Return Loss:	20 db from 20 to 40 MC
Accuracy:	± 0.5 db, 0 to 12 db; ± 1 db, 12 to 20 db
Repetition Rate:	90 to 500 pps, as specified
Total Duty Factor:	0.075 + (100 μsec) × (PRF)
Input Trigger:	3 v pos. peak, 3 μsec duration
Output:	100 μamp into 2,000 or 3,000 ohms
Temperature Range:	0 to 52° C
Humidity:	95%
Power:	115 v ± 10%, 50/1,000 cps, 20 to 40 watts (depending on noise source and duty cycle)
Dimensions:	5¼″ high, 19″ wide, 8″ deep.
Price:	$1,600.00 approximate. Depends on options and modifications.

hp 340B/342A Noise Figure Meters



General-purpose instruments making possible, in minutes, receiver and component alignment jobs that once took hours. Simplify accurate alignment; encourage better maintenance; better performance.

340B automatically measures, continuously displays noise gure of IF amplifiers or microwave devices with output at or 60 MC. Other frequencies on special order. Operates oth temperature limited diodes or hp 347 Waveguide Noise ources. $715.00 (cabinet) $700.00 (rack).

342A, similar, operates on 30, 60, 70, 105, 200 MC. 30 MC nd 4 other frequencies between 38 and 200 MC on special der. $815.00 (cabinet) $800.00 (rack).

ote: Models 340B and 342A available only in the U.S.A. and Canada.)

hp 343A vhf Noise Source, temperature limited diode broadband source, 10 to 600 MC, 5.2 db excess noise, $100.00.

hp 345B IF Noise Source, 30 or 60 MC (others to order); 4 impedances, 5.2 db excess noise. $75.00.

hp 347A Waveguide Noise Source. Argon gas discharge tubes in waveguide sections; for bands S, G, J, H, X, P, 2.6 to 18.0 KMC, 15.2 db excess noise. $190.00 to $250.00.

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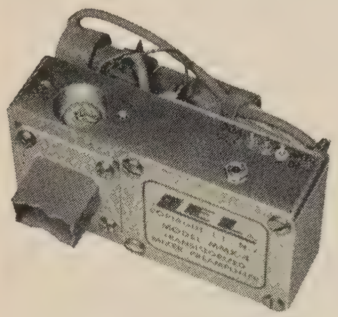
LOW NOISE

for
C Band

The MMC Series of Integrated Waveguide Mixer-Preamplifiers.

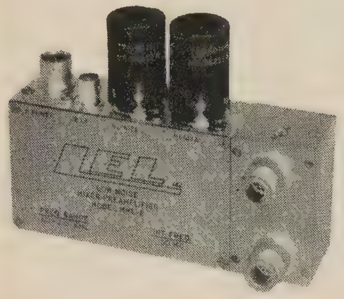
Noise Figure: 7.5db



for
X Band

The MMX Series of Integrated Microwave Mixer-Preamplifiers.

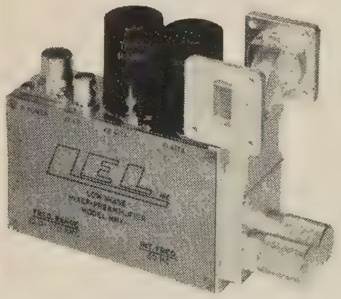
Noise Figure: 7.5db



for
L, S and C Bands

The MML, MMS and MMC Series of Coaxial Mixer-Preamplifiers.

Noise Figure: 7.5db



for
KA and KU Bands

The MMK Series of Integrated Microwave Mixer-Preamplifiers.

Noise Figure: 10.0db

LEL stocks the most complete line of low noise microwave Mixer-Preamplifiers available ANYWHERE.

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(*Continued from page 11*)

GE NAMES COMMUNICATION DEPARTMENT TO DEFENSE ELECTRONICS DIVISION

General Electric's Communication Products Department has been transferred from the company's Industrial Electronics Division to the Defense Electronics Division. The Department maintains its headquarters in Lynchburg, Va., and has engineering and manufacturing facilities both in Lynchburg and Syracuse, N.Y.

Harrison Van Aken, communication products general manager, said the realignment was made to bring communications technologies in which GE Communications has military competence into closer relationship with military technologies of other departments of the Defense Electronics Division.

At Lynchburg, the department produces mobile, portable and pocket radio units for the defense services. It has Air Force contracts involving advance research on push-button digital communications for air-ground and ground-air use and has been engaged in development of over-the-horizon tropospheric scatter equipment applied in the Arctic. Also from Lynchburg, the department supplies the military with other point-to-point communication devices, including microwave and multiplex-carrier systems.

In Syracuse, the department's Technical Products Operation makes high-powered broadcast equipment and closed circuit television, including specialized systems for intelligence briefings, weather reporting and missile-monitoring. The Syracuse operation has also been active in work on radio frequency induction heating used to simulate high-temperatures encountered in high-speed space flight.

— *mwj* —

CANOGA REVEALS BIG GROWTH FOR FIRST FOUR MONTHS OF 1960

Canoga, Van Nuys, Calif., a division of the Underwood Corporation, has received $3 million in antenna instrumentation and component contracts during the first four months of its current fiscal year, Canoga Vice President Myron Roebuck announced.

This compares with a $3.5 million annual volume for the company's entire 1959 fiscal year.

Current contracts include research, development and fabrication for Man in Space Project Mercury, the Air Force, Republic Aviation, Raytheon, Lockheed and the Navy.

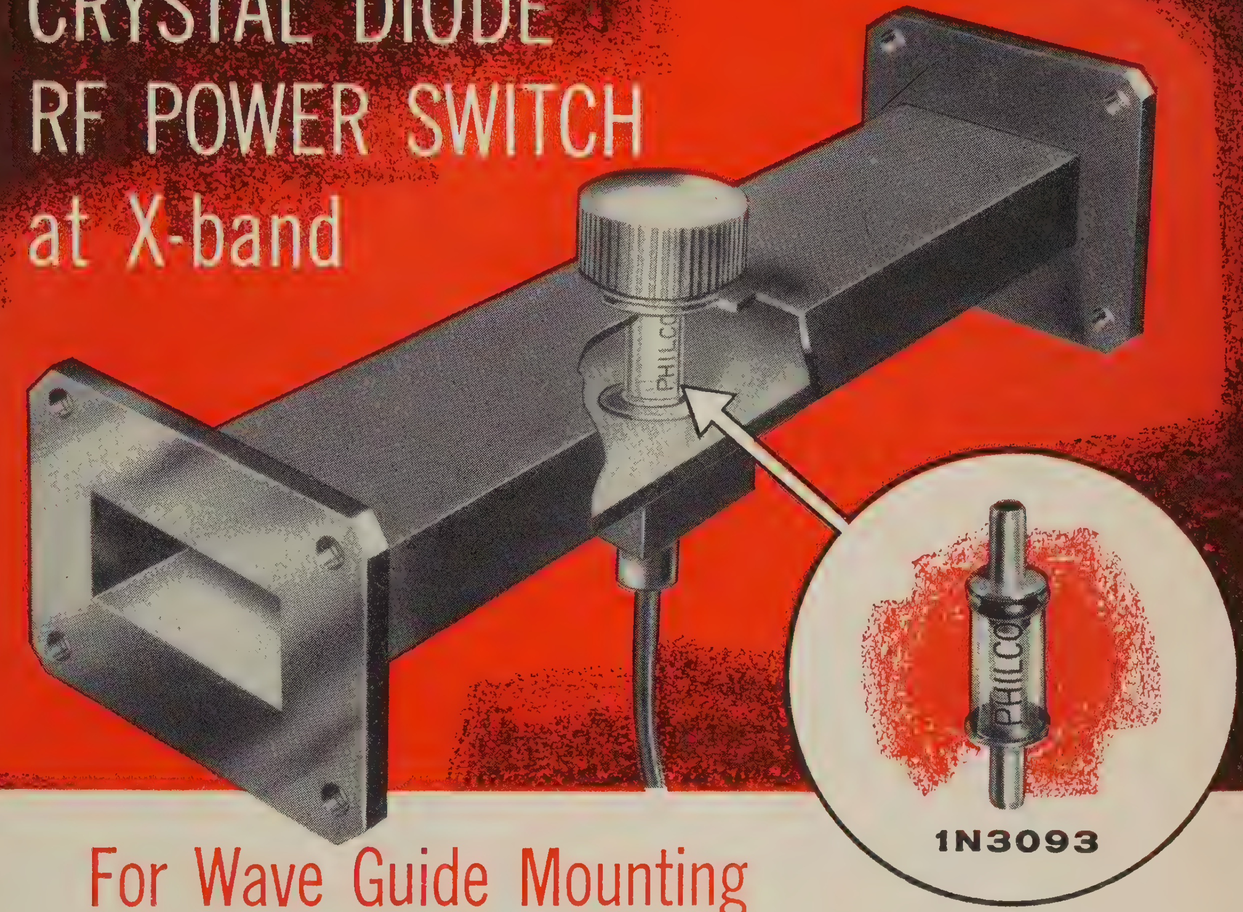
These contracts cover ground instrumentation antennas, microwave components, distance measuring equipment, data link and data processing systems, timing equipment, aircraft instrumentation and radar safety systems.

— *mwj* —

(*Continued on page 22*)

PHILCO ANNOUNCES

the first CRYSTAL DIODE RF POWER SWITCH at X-band



For Wave Guide Mounting

1N3093	Min.	Max.
Insertion Loss (F=9300 mc)		2.0db
Isolation (F=9300 mc)	18db	
Forward Current Rating		60ma
Reverse Voltage Rating		11v
Microwave Power Level		100mw

■ This new Philco germanium crystal diode has bee specifically designed for use as a microwave switch in th X-band frequency region (8,200 to 12,400 mc). As show in the illustration above, it may be placed in a conventiona mount, centered on the wave guide axis. *The 1N3093 wil switch powers up to 100 mw . . . at speeds of less than 1 nan second.* It may be used for switching in transmitter circuits receiver circuits and signal processing circuits . . . also fo antenna switching and for RF modulation. The 1N3093 i symmetrically designed and is packaged in a hermeticall sealed glass and metal case. For more complete informatio and prices, write Special Products Operation, Dept. MJ-860

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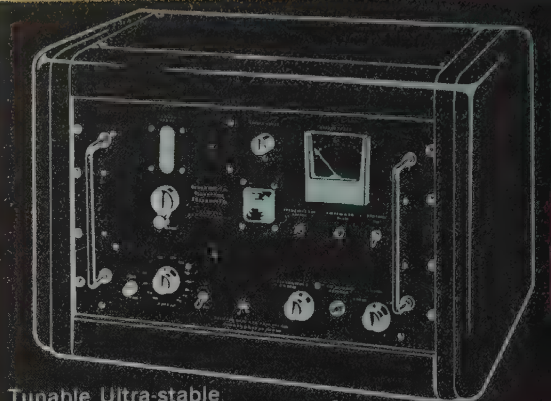
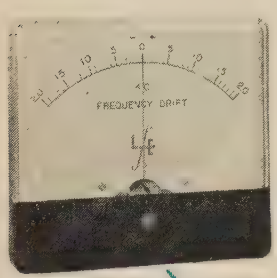
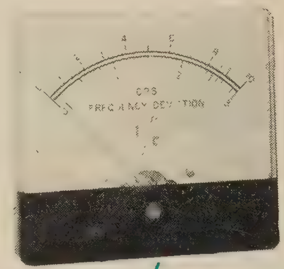
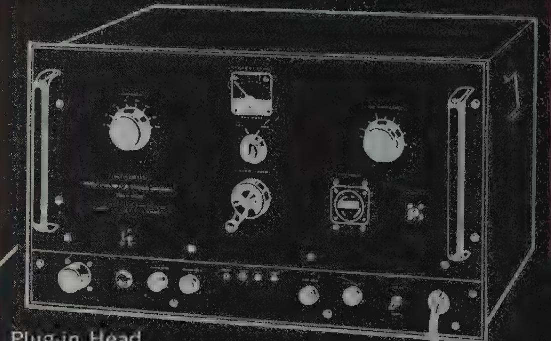

Tunable Ultra-stable Microwave Oscillator — Series 814

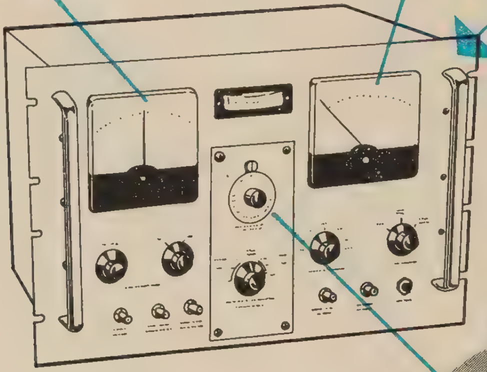


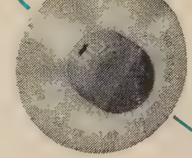
Long Term

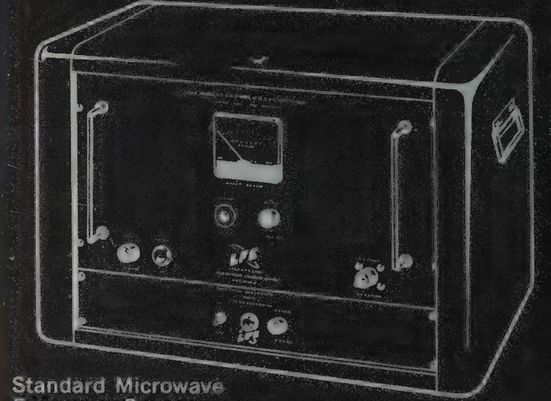


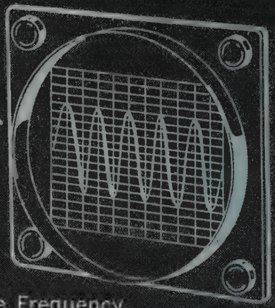
Short Term


Plug-in Head and Power Supply — Model 5009R


Microwave Stability Tester — Model 5009R




Standard Microwave Frequency Source — Series 820XLK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For the *measurement* of ultra-stable microwave frequencies LFE Model 5009 measures drift and f.m. in frequency bands between 100 mc/s and 10.8 kmc. The unit is capable of measuring f.m. deviation from 1 cps to 20 kc at RF and 0.1 cps at 30 mc.

For further information write for complete specifications. This equipment is also adaptable for modification to specific systems requirements.

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new high-power harmonic ABSORPTION filter for SL band—1700 to 2400 mc

Harmful harmonic interference from high-power microwave equipment should be, **and can be,** eliminated at the source. These unwanted signals literally disappear when passed through Sierra's new Model 204A Waveguide Filter.

Representing a new approach to the elimination of harmonic interference, the Model 204A actually absorbs the unwanted energy with no appreciable attenuation of fundamental signals within the pass band. High order harmonic, as well as low order, are equally attenuated.

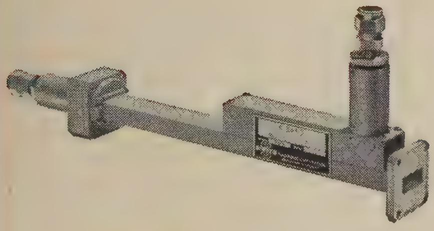
Currently available for SL band frequencies, Model 204 type filters can be supplied for other frequency ranges on special order. See your Sierra representative or write direct.

Sierra 204A SL Band Pass Filter

SPECIFICATIONS

Pass Band:	1700 to 2400 MC
Insertion Loss:	Less than 0.1 db in pass band
VSWR:	Less than 1.1 in pass band; less than 1.3 above pass band
Attenuation:	40 db minimum, 3400 MC to 11000 MC Same as RG-104/U below pass band
Maximum RF Power:	25 KW average, 1 megawatt peak
Size:	45" long, 12⅜" wide, 10⅜" high; weight 120 pounds.
Connections:	UG 435A/U Flange
Price:	Model 204A (SL Band) $2,195.00

Data subject to change without notice



WATER LOADS FOR POWER MEASUREMENT

New Sierra Water Loads permit convenient, accurate calorimetric wattage measurements; also serve as dummy loads and terminations.

For average powers up to 100 to 2000 watts, dc to 4 KMC, Sierra offers Model 186A Coaxial Liquid Cooled Load. For waveguide measurements Sierra offers 187 Series Water Loads covering the X, XB, C, S, and SL bands with average power limits of 2, 3, 5, 10 and 20 KW respectively. Also available: Sierra 287 series Dual Water Loads for balanced measurements in X, XB, and C bands. Sierra 287A Loads include thermopile. To dependably measure power dissipated in other loads, Sierra Model 189A Differential Thermopile is recommended.

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THE MICROWAVE ENGINEER'S HANDBOOK

The publishers of *the microwave journal* would like to take this opportunity to announce the preparation of a microwave handbook and catalogue for publication in the spring of 1961.

For some time we have felt that an item that would be of great service to our readers is a collection of charts, nomographs, graphs, tables, etc., all devoted to microwaves. There are many available in different publications, and some publications have a fairly good collection. However, it is the feeling of *the microwave journal* publishers and editors that, again, the microwave engineer is either inadequately served or his field of interest is handled as a small part of the entire electronics field.

To help solve this problem, we are now in the process of collecting and editing as much useful information as possible, which pertains specifically to microwaves. In addition to the technical information, we hope to have as complete a microwave directory of products as possible. We will invite advertisers to include their short form catalogues, etc.

As in the case of *the microwave journal*, the expense of the handbook will be borne by our advertisers; and, consequently, it will be mailed free to qualified individuals.

At the present time we are making a collection of information that our editors have in their files. We would like to invite individuals and companies, both, to submit their own special curves, tables, etc. The suppliers of all items published will be duly credited in the handbook, and a nominal fee will be paid for each item used. Since there will undoubtedly be many duplications, the editorial board will have to be the final judges of the material to be published. Our present plan is that we will have our first handbook and catalogue ready for mailing about March or April of 1961.

It is planned that the microwave handbook and catalogue will be published on an annual basis. With each succeeding year, we will revise, expand, and improve the handbook section. Your participation is cordially invited.

While we make plans for the future, our main area of interest, this magazine, continues to bask in the sunshine of your good graces. We are especially pleased with the number of good papers we have been receiving. We hope this situation will continue.

I would like to call your attention to an especially fine paper that will appear in *the microwave journal* starting in September. It is a three part paper entitled "Electromagnetic Properties of Ferrimagnetics and Their Application From UHF To Millimeter Waves" by Dr. Ben Lax and Ken Button of Lincoln Labs. Although the paper is basically a review article, it contains much that has never been published previously.

Ted Saad

new

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8,200mc to 12,400mc Frequency Range

Advanced Features Include:

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>
> *David Charles*

FXR Model X775A X-Band Sweep Signal Source, challenging comparison, is unsurpassed for the surement of VSWR and reflection coefficient. The Model X775A utilizes a permanent magnet BWO he rf source. A unique built-in AGC amplifier produces a flat rf level, with respect to a bolometer ctor, over the entire swept frequency range. Both ends of the swept frequency range can be accurately et on separate direct reading frequency dials.

cifications for the FXR Model X775A:

- **FREQUENCY RANGE:** 8,200mc to 12,400mc.
- **SWEEP RATE (RESOLUTION):** 300mc/sec to 300kmc/sec, linear with time.
- **SWEEP WIDTH:** to 4,200mc, direct reading, continuously adjustable.
- **OUTPUT TYPES:** cw, square wave modulation (internal 800cps to 1,200cps).
- **OUTPUT POWER:** 0 to 20mw minimum cw into matched load, continuously adjustable. With AGC-detected output flat to ±0.5db (when used with matched bolometers and directional couplers).
- **FREQUENCY DIAL ACCURACY:** ±1% — fixed frequency operation (at specified grid voltage).
  ±2% — sweep frequency operation.
- **OUTPUT CONNECTOR:** 1 X ½ waveguide.
- **POWER REQUIREMENTS:** 115/230V, 50/60cps, 200 watt.
- **DIMENSIONS:** 12⅞" high X 21¾" wide X 18" deep.
- **WEIGHT:** 78 lbs.

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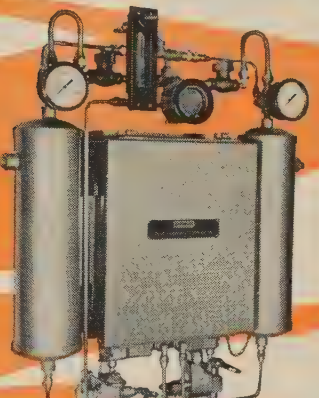

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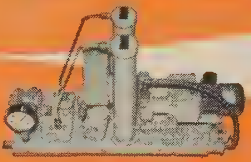

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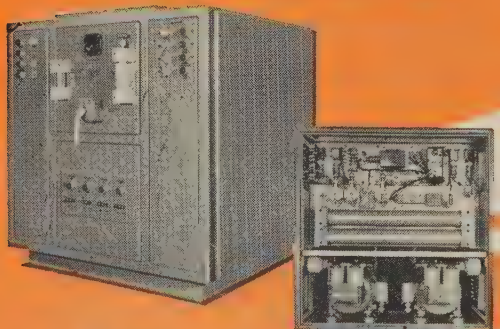

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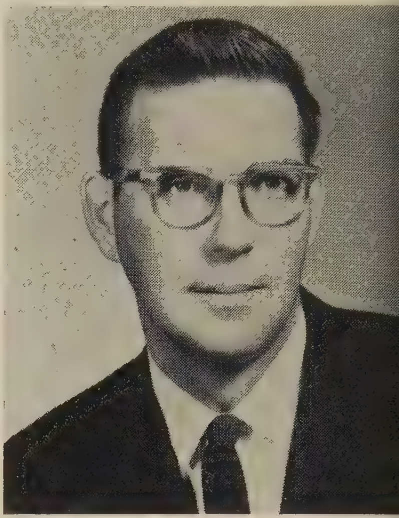
(*Continued from page 16*)

DR. GRANT ST. JOHN APPOINT DIRECTOR OF RESEARCH AND DEVELOPMENT — MICROWAVE ASSOCIATES TUBE DIVISION



Microwave Associates, Inc., Burlin ton, Mass., has announced the appoin ment of Dr. Grant E. St. John as direct of Research and Development of its Tu Division. Dr. St. John will supervi Microwave Associates' current resear programs in magnetrons, duplexer tub and beam-plasma amplifiers, and will i itiate new programs which will ultimat ly lead to the company's entry in traveling-wave and crossed-field devic

Prior to joining Microwave Associate Dr. St. John was a senior project Eng neer with Watkins-Johnson Company Palo Alto, Calif., where he directed pr jects concerned with low-noise travelin wave tubes and beam-type parametr amplifiers.

Dr. St. John was with Bell Telepho Laboratories — Electron Tube Develo ment Department, Murray Hill, N. from 1952-1959 as supervisor of a grou working on research and development low-noise traveling-wave tubes for radi relay usage.

At Bell Telephone Laboratories D St. John was a lecturer for several yea in the Communications Developme Training Program and was also a speci lecturer in the Physics Department Drew University, Madison, New Jerse

He received his Bachelor's degree engineering-physics from the Universi of Toronto in 1949, and his Master's a Doctoral degrees in physics from th University of Toronto in 1950 and 195 respectively. He held the McKee-Gi christ Fellowship while at the Universi of Toronto.

Dr. St. John holds several travelin wave-tube patents.

— *mwj* —

(*Continued on page 64*)

ATURES:

- new low in noise levels — down to .007 µv providing 0.02 µv full scale ensitivity at minimum bandwidth.
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ECIFICATIONS:

quency: 1,000 cps; adjustable over a % range.

sitivity: 0.02 µv at minimum (4 cps) ndwidth. 0.1 µv at maximum (40 ps) bandwidth.

e Level: 5db below full scale (0.007 at minimum bandwidth).

plifier Q: 250 at 4 cps; 25 at 40 cps.

dwidth: Continuously variable from 4 40 cps.

ibration: Square Law. Meter reads WR, db.

ige: 85 db. Input attenuator provides 0 db in 5 db steps. Gain control proides 15 db adjustable. Accuracy ±0.1 b per 10 db. Maximum cumulative rror of ±0.2 db at 40 cps bandwidth.

le Selector: Expanded, Regular, and olometer Current. Meter scale always ormalized when switching from xpanded to regular.

er Scales: SWR: 1-4; SWR: 1.8-6; WR: 3.2-10; SWR: 6-15; Expanded WR: 1-1.3; db: 0-10; Expanded db: 2.3.

ut Selector: 220,000 ohms; Crystal; olometer. Bias provided for 8.75 ma olometer or 4.3 ma bolometer. Bias djustable ±15%. A bolometer protecve circuit permits any switching operaon or cable connect-disconnect without amage to bolometer.

put: Jack for 1500 ohm recorder, 1 ma ll scale deflection.

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this standing wave amplifier defies comparison

The new portable PRD 277-B Standing Wave Amplifier is designed to meet the present and future needs of microwave test laboratories. Due to its extremely low inherent noise, 0.007 µv, weak signals which once were undetectable by conventional instruments can now be measured. Attenuation in 5 db steps combined with 4 VSWR scales and a large meter permit VSWR measurements to be made with maximum resolution and accuracy.

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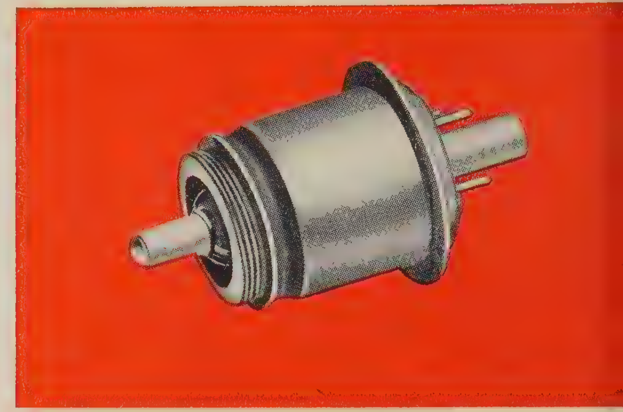

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Du Mont Type 6280 Planar Triodes are used extensively as CW, AM or FM r-f power amplifiers—providing 0.5 watt average power up to 5000 mc. Its low noise and 1000 mc tuning range characteristics make them ideal in point-to-point microwave relay systems for high quality voice transmission, in instrumentation of all types, and in pulse modulator or SSB applications—providing 10 watts peak power.

The 6280/416B fulfills requirements in a myriad of broad band r-f amplifier applications, such as in radar systems, microwave relay links and multiplex transmission systems of all types. At 500 mc a noise figure of only 5.5 db is available.

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THE FERRITE MARKET

GERSHON J. WHEELER
Associate
the microwave journal

cs of microwave ferrite devices this year will exceed
million dollars. Five years from now, sales should
least five times this amount. But besides being larger,
market will also be different from what it is today.
present, most ferrite devices are sold as individual
es of hardware which are joined to other pieces of
ware to make a complete system. However, there is
owing tendency to design the ferrite into the complete
m and to market a complete r-f package in which the
te device is only a small part. By 1965, it is expected
this trend will become an established way of doing
ness, requiring systems engineers with a knowledge of
tes or vice versa.

errite devices include an assortment of isolators, cir-
tors, phase shifters, modulators, and switches, as well
many special components. The portion of the total
ket which any one type has captured is continually
ging, and the "product mix" will be radically differ-
in 1965 from what it is today. What follows is a wild
s as to what the future holds.

steady seller in the ferrite market is the waveguide
tor for laboratory use. This is usually a broadband,
power device with no environmental specifications.
sales of this unit are under half a million dollars,
ably five per cent of the total market. It is quite
y that five years from now sales will still be pushing
half million mark, or about one percent of the market
hat time. For some strange reason this market never
rates. New companies are formed, new laboratories
opened, and each one orders a few more of these old
dbys.

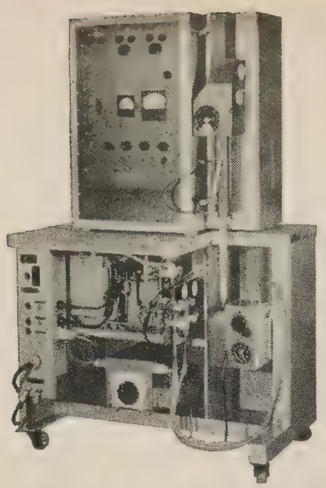
his isolator, in the main, will be sold as a separate en-
resisting the trend toward packaging mentioned
ve. Nevertheless, even here there will be some con-
lation. Devices will be combined with directional couplers, power dividers, and other standard units used in laboratory bench set-ups. Some of these isolators will be included as part of the circuitry inside the cases of generators and signal sources. But many of these packages will be sales gimmicks rather than devices designed to meet a demand. The engineers will still prefer the flexibility of separate units in the laboratory, since space is usually not a problem there.

Unlike the standard line of low-power laboratory isolators, high power isolators are almost always special and must be custom-tailored for each application. The design of a high power isolator is always affected by specifications of isolation, insertion loss, power handling capability, bandwidth, and environmental conditions. Each application is different in one or more of these specifications, and, since most requirements push the state of the art, the designer must take advantage of every opportunity to loosen some objectives in order to tighten others.

Although the individual devices may look different and have different specifications, essentially the same techniques will be required to develop them. The applications will be different five years from now. That is, there will probably be a decrease in fire control radars, for example, while there is an increase in radars for airborne mapping and surveillance. But, in general, the market for high power isolators will increase three-to five-fold.

As new materials are developed, isolators will be designed for lower and lower frequencies and for higher and higher powers. Today there is a negligible market in devices below L-band, but by 1965 there will be a steady growing demand for vhf and uhf isolators. Power handling capabilities at all frequencies will be increased by at least an order of magnitude.

(*Continued on page 26*)



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Accessories now available: *Temperature Control Unit.* Enables dielectric properties of solids to be measured at any temperature between −30°C and +500°C; liquid samples to +150°C. Includes waveguide extension and sample holders for solids and liquids.

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For brochure giving details and specifications, write:

Central Research
laboratories, inc.
Dept. 203 — Red Wing, Minnesota

Circle Reader Service Card 19

The Ferrite Market

(*Continued from page 25*)

There will be an ever-increasing market in ferr duplexers. This market is small now, but by 1965, it v probably surpass the isolator market. Most of today's f rite duplexers are four-port phase-shift circulators. F years from now, the majority will be tee or wye, three four-port circulators, with the phase-shift devices reserv for extremely high peak applications. The gas-tube crys protectors now necessary with ferrite duplexers will be placed by ferrite limiters.

The ferrite limiter today is more a laboratory curios than a practical device. Its extremely narrow bandwi and high insertion loss drastically limit its applicati However, these problems are being studied, and when th are solved, the limiter will be used in practically ev radar, exceeding the circulator in numbers but not sales dollars.

Non-linearites in ferrites, such as limiting, are bei studied in a number of laboratories and may lead to ot useful devices. There may be developed new types detectors, amplifiers, or microwave delay lines, all which would have wide application and, consequen tremendous market potential. But other devices may a be developed which are today not even imagined. P sumably, these would augment rather than supplant exi ing ferrite devices, so that the whole ferrite market wo increase beyond the original forecast.

There is a small market in special ferrite devic These include switches, phase shifters, regulators, atten tors, modulators, and some narrow bandwidth filters. T market for all of these will undoubtedly increase, b except for filters, it will probably remain small. The of ferrite in filters has resulted in practical narrow-ba and tunable devices which should have wide applicati

There is a steadily growing market in medium a low power isolators and circulators for commercial u Applications include microwave communications and lay links, marine navigation, fish-finding radars, ra cooking and drying, and radio astronomy. These units not have stringent environmental specifications to m and thus will be simpler and cheaper than devices ma for the military. However, quantities will increase, a despite price cutting as a result of stiff competition, th devices will account for an appreciable share of the sa dollar.

The military also will be interested in some low po units. Navigational aids, reconnaissance radars, battlefi surveillance, and others will require special devices. Th will probably have simple electrical specifications, difficult environmental requirements. The market in th devices will be moderate, but still growing, in 1965.

Ferrite antennas have not been included in this surv since in general the antenna work is not done by the sa groups who manufacture ferrite waveguide componen The use of ferrites in antennas for electrically controll scanning or for rapid scanning is a slowly growing fie The market potential by 1965 is not known (by me).

It is customary in making a prediction of things

(*Continued on page 28*)

ow Indiana Steel's engineers elp you solve micro-wave magnetic problems

neers at The Indiana Steel ucts Company are in constant ct with leading manufacturers cro-wave equipment on prob- involving permanent magnets. ltations with Indiana's magnet lists have resulted in time and savings — often eliminating sive redesign.

E IN POINT:

ding micro-wave component facturer. *Problem:* Produce a l load isolator magnet to fit r space contour in a new radar Also, deliver the new magnet customer in 12 days.

ution: Indiana engineers turned eir previous design files, se- l an existing magnet and modi- t to meet the new size specifi- ns. Gauss tests showed that the design met the customer's fied magnetic field range. The et was delivered within the specified.

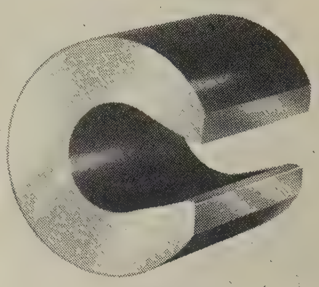
is is just one of many hundreds ses where Indiana permanent et specialists have applied their ualed experience to solve a mag- roblem *ahead* of a customer's ine. Indiana not only has the neering know-how, but also facturing equipment from pre- ly designed magnets which may be quickly adapted to meet special requirements.

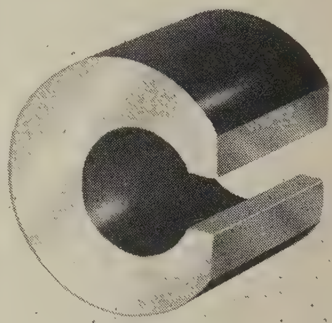
THREE BASIC DESIGNS FOR LOAD ISOLATOR APPLICATIONS

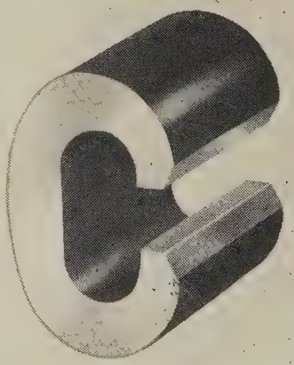
Permanent magnet specialists at Indiana Steel utilize three basic magnet designs for load isolator applications. These are, two variations of the C magnet, and the U magnet. All three of these designs can be varied to meet specific customer requirements. Actual size and shape of any individual magnet is dependent upon size limitation of the load isolator, and the magnetic field strength needed.

WIDE EXPERIENCE IN MICRO-WAVE APPLICATIONS

Magnet specialists at Indiana have designed and produced permanent magnets for a wide range of micro-wave applications including pm-focus traveling wave tubes, load isolators, radar magnetrons, backward wave oscillators. And, you can be sure the material selected is *best* for your particular application because Indiana Steel produces *all* permanent magnet materials. Our engineers will give prompt attention to your micro-wave problems or any other permanent magnet applications. Call your Indiana man or write us direct. Ask for Catalog No. 20, "Alnico V Load Isolator Magnets." Dept. Q-8


U Magnet


C Magnet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Now !
The Oki
Klystron
50V10
Makes Possible
Greater Stability
and Output
Than Ever Before

The 50V10 is a reflex Klystron for 6mm band and is tunable over a range of from 6mm to 7mm. The nominal output is 40 mW at 48,000 MC. Ample, stable output power of approximately 100mW can be obtained with this Klystron which is vastly superior to that of conventional types used hitherto in this band. Besides, we are manufacturing various types of Millimeter Wave Tubes as listed below.

Item No.	Model No.	Frequency Range	Power Output	Operating Voltage	Operating Current
—Klystron—					
1	35V10	33~37KMC	40mW	2,000V	12mA
2	35V11	33~37	100	2,000	25
3 *	50V10	43~51	40	2,300	25
4	70V10	65~75	15	3,500	30
—Magnetron—					
1	24M10	24,000MC	50KW	13KV	15A
2	33M10	32,600	40	13	18
3	35M10	34,860	40	13	18
4	50M10	50,000	20	12	16

*TENTATIVE DATA

OKI
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Circle Reader Service Card 21

The Ferrite Market

(*Continued from page 26*)

come to put in a "hedge" so that no matter what happ the author can say, "I told you so." Here's the hedge: foregoing predictions apply if progress in non-competi lines (such as tubes) is comparable, while progress competing lines (such as TR's) is much slower. course this isn't likely. Thus some revisions must be m in the forecast.

From this position of ignorance, it is difficult to imag anything replacing ferrites in isolators or circulators 1965 or beyond, although it must be remembered t tube manufacturers couldn't foresee the transistor. Nev theless, the foregoing predictions for isolators and cir lators in 1965 should be approximately correct. W infrared replace radar? Will world peace reduce military budget? Not likely, by 1965.

But outside of isolators and circulators, there may no ferrite market at all. Varactor diodes, presenting power-sensitive capacitance, could take over the n linear ferrite applications such as limiting. As a matter fact, diode limiters have already been built at vhf a L-band, and it is only a question of time before diodes v be developed to operate satisfactorily at higher frequenc These diodes and other crystal diodes have been used switching applications, also. Since they are volta operated, and a voltage can be changed faster than magnetic field, diode switches can be operated at m higher switching speeds than a ferrite device.

Ferroelectrics, likewise, have been operated at lov frequencies, and it is only a question of time until losses at microwaves will be reduced sufficiently to per satisfactory operation. Ferroelectric switches also are c trolled by a voltage and have the advantage of being a to handle high power signals, while the diodes are limi in power-handling capability. By 1965, all switching v be better performed with ferroelectrics or diodes ratl than with ferrites.

Ferroelectrics will almost certainly be developed microwave use, since this is a major effort in many labo tories. Applications for a voltage-controlled dielect constant are many and include most special uses of ferri Ferroelectrics will make better phase shifters, modulat and frequency shifters. For many applications ferroelect tunable filters will be better than ferrite filters.

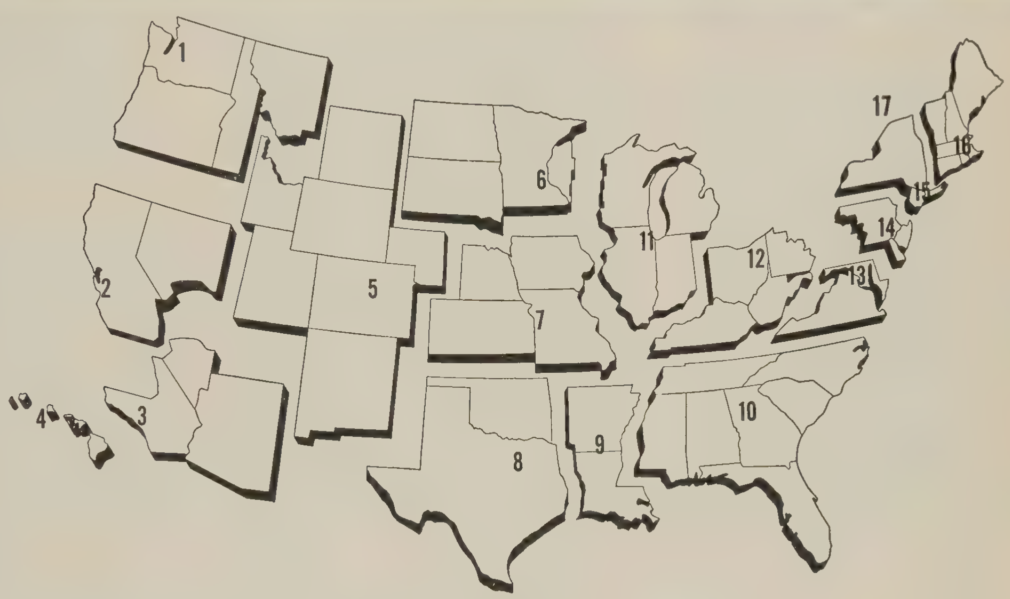
It is likely that the same people who develop a manufacture ferrite devices will be the first to develop a manufacture devices using the new materials. Theref with a slight change in wording, the original predict in the first two sentences of this article still holds. Sales *special microwave devices* this year will exceed eight n lion dollars. Five years from now, sales should be least five times this amount.

Eight years ago there was only one company ma facturing ferrite devices for sale. Today there are a doz Many new ones will start in the next five years but 1965 many will drop out. It is unlikely that more t twenty companies will be manufacturing special mic wave devices at that time.

Your TWT requirements designed into rugged new Eimac X778

To meet your application requirements, the advanced new X778 ceramic-metal TWT has been especially designed to operate under severe environmental conditions. Its unique features include exceptionally wide frequency range—5.0 to 11.0 KMc., small signal power gain of 55-60db, and lightweight permanent-magnet focusing.

Ask your nearest Eimac Sales Engineer about complete product specifications and data on this new X778 one-watt CW tube. Ask him, too, about any specific application problems. He is your direct link with Eimac's Research and Development Program. And, at Eimac, *your* needs directly affect product planning and production.



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ANTENNA TOWERS & STRUCTURES

Dresser-Ideco Designs, Fabricates, Erects A Wide Variety of Large Land-Based Antenna Structures

Whatever the antenna tower or structural problem, Dresser-Ideco can handle the job. A large technical service staff, more than a quarter-million square feet of well-equipped production area, extensive research and development facilities, and many years experience designing and erecting steel and aluminum structures qualify Dresser-Ideco as a major contractor for any type of antenna tower . . . from 100 to 2000 feet. Below are some of the many types of Dresser-Ideco towers serving the nation's communications and military electronics facilities.

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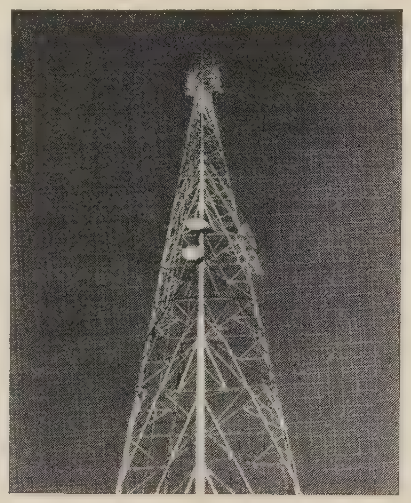
B.

C.



A. Multiple antenna tower. This big 729′ tower in Baltimore supports three television antennas on a 105′ wide platform at the top.

B. Antenna test range tower for height finding radar.

C. Microwave antenna tower typical of those used in systems built for the Ohio Turnpike and the Illinois Toll Road.

D. Surveillance radar towers on the DEW line. Designed for hurricane force winds and heavy ice and snow loads. These are some of more than 1,000 radar towers built by Dresser-Ideco for the nation's early warning systems.

D.

Dresser-Ideco offers a complete tower and structural service—design, application, field installation. Call or write for consultation on your structural problems at no obligation. Send for booklet "Facilities For Defense Production". Dresser-Ideco Company, A Division of Dresser Industries, Inc., 875 Michigan Avenue, Columbus 15, Ohio.

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Circle Reader Service Card 23

Dr. Edward L. Ginzton

PROFESSOR
STANFORD UNIVERSITY

APPLIED PHYSICS
ELECTRICAL ENGINEERING

By
DAVID H. SIMON

Dr. Edward L. Ginzton: board chairman, Varian ates; professor of Applied Physics and Electrical ering, Stanford University; director of Stanford rator Project.

in the nineteenth century, reports of a gold strike ka spread like wildfire throughout this country and the imagination of the adventurous. People in walk of life gathered up their savings, borrowed, ole to finance the trip and buy equipment. In New an uneducated teenager sold most of his meager sions except for a few items of warm clothing, his way across the continent and into the already-ed gold country. This aggressive youth, Leonard zton, was among the small percentage of the for-: he panned high-grade ore soon after he started k his first claim. Others, not so fortunate, straggled o their homes penniless, but the elder Ginzton re-d to work his mine. After a few years, restless and s to spend some of his accumulated wealth, he sold nd moved to San Francisco where he remained , until wanderlust once again overtook him. This e set out to see the world and after some roaming tled for several years in Switzerland and embarked first formal schooling. Then, hearing that there new and exciting things going on in Russia he to Siberia, continued his education, and in 1910 ed the Doctor of Medicine degree from the Uni- of Tomsk at the age of 35. While there he met r medical student, a Russian girl, and married her. years later, on December 17, 1915, Edward Leon-inzton faced his first day, a bitter one with the ro temperatures typical for that time of year.

oppressive weather soon proved to be a minor however, for with a war and then a Revolution it bad time and a bad place to try to raise a child. ountry was in turmoil: the famine, poverty, dis-nd chaos which had characterized the declining days Czarist regime worsened instead of improving. mplicate matters, the family was seldom together the Doctors Ginzton were given work assignments by the new governments which required them to travel extensively. Schooling was another problem: there was none, because virtually nothing was permitted to remain from the fallen Czarist system. Everything had to be re-established and re-organized in its turn. The basic elements of reading and writing were taught to Edward by his mother during some of their brief periods together.

In 1924 Edward became ill, and an examination revealed the possibility of tuberculosis. He was sent to the Black Sea where he spent many long, relaxing hours in the sun to regain his health. His mother moved with him, but she was given an assignment as Public Health Officer on a raliroad operating between the Black Sea and Moscow. As before, Edward was by himself most of the time.

One of the things Edward did to amuse himself was to put together a radio his father had brought him, in the form of an early "do-it-yourself" kit. He enjoyed the challenge, but much to his disappointment it didn't work. Almost a year later, while rummaging through some playthings he came across the radio and plugged it in. To his amazement, this time it worked (Later he learned that the first local station had not been constructed when he had originally tested the set). The sounds of music and voices that emanated from the radio gave him a great sense of accomplishment, and he knew that one day he would study engineering. "From that moment on," he says, "there was never any question in my mind about what I wanted to be."

By 1927 Edward's father had become restless in the difficult days of the Communist regime and by the continued separation of his family. He longed to return to America. But professional people were an important part of the new system; to release two doctors, he knew, would be out of the question even though he still retained his U. S. citizenship. Instead, he applied for and received assignment as Public Health Officer on the Chinese Eastern Railway in Manchuria and with the new post came permission to take his wife and son along. In addition

(*Continued on page 32*)

Dr. Ginzton

(*Continued from page 31*)

to reuniting the family, this served to get the Ginztons over the Russian border and onto Chinese soil.

Edward, who was then 11 years old, was sent to a school established in the area for the Russian colony, where he was placed in a grade on the basis of his age rather than his knowledge. It took only a few minutes for him to realize that he was far behind the other children: the teacher realized it at the same time, and Edward was swiftly relegated to the first grade classroom. Feeling terribly inadequate because he was so much bigger than all the other first-graders, he ran home in tears. His mother wisely understood his plight and instead of forcing him to return, she hired a college student to tutor him. Edward learned quickly, for after about six months of private lessons he was able to return to school.

He spent one year in school before the long awaited day arrived: his father managed to arrange to get the family out of Manchuria and into the States. Edward set foot on San Francisco soil at the age of 13, and once again he was placed in class according to his size — this time into the sixth grade. From his tutoring, and because his European school was superior to its American counterpart, Edward was far ahead of his classmates. (He'd already had two years of algebra and a year of chemistry and physics.) But since he spoke virtually no English he was unable to keep up. He was dropped to the 5th grade on Tuesday, the 4th grade on Wednesda Continuing this negative advancement smoothly and co sistently, Edward quickly found himself back in fir grade. It was a familiar experience except that it ha taken a week longer the second time. In the few inte vening years, though, he'd gained a little wisdom ar perhaps a somewhat tougher shell. In any case, this tin he stuck it out, and as he grew more proficient in Engli he reversed the trend and started on a rapid upwa climb. It took only a few weeks to get back to the 6 grade and a total of 7 months to graduate from juni high school. Having gained his stride, he finished hig school in another 2½ years, graduating in the fall 1932. Among the memories from his high school day he received the only A in his freshman English cla but, "It wasn't as hard as it sounds. My English was f from perfect but we were studying Shakespeare, and did a better job of memorizing than anyone else."

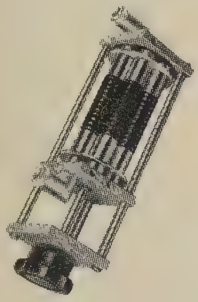
After graduating from high school he entered the Ur versity of California at Berkeley. ("Make sure you speci Berkeley," he says. "It might not make much differen to Eastern readers, but it's night and day to anyone wh lives in Northern California.") While there, he met ar married Artemas McCann. (With the humility whi characterizes his whole way of life, Dr. Ginzton ne lected to mention as college-day achievements that was elected to Sigma Xi, and Tau Beta Pi and Eta Kap Nu.)

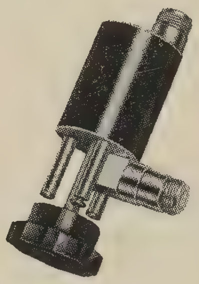
(*Continued on page 34*)

Dr. Edward L. Ginzton

MINIATURIZED TURRET ATTENUATORS
FROM 0 TO 10 KMC
FOR IN-LINE AND PANEL MOUNTING

From MICROLAB, here is a complete line of miniaturized turret attenuators for use as laboratory instruments or components in military and field equipment.





AS Series—
Six fixed attenuators mounted about a central shaft and selectively engaged by means of a coaxial switch. For use in the 4000 to 10,000 mc region, they are the only turret attenuators available that can be used in the X band range.

AT Series—
Similar in design to the AS Series, they are designed for use in the DC to 5000 mc range and are available in 2, 5 and 15 watts.

AV Series—
The smallest, lightest variable step attenuators available, they consist of six or more coaxial attenuators mounted within a single housing. Characterized by low VSWR and zero insertion loss, they are used from DC to 2000 mc.

AW Series—
Waterproof, environmental-resistant, variable step attenuators for use from DC to 4500 mc with low VSWR and zero insertion loss. Their low cost and rugged design make their use practical where other models are prohibitively expensive and delicate.

For in-line mounting.

AX Series—
Waterproof, environmental-resistant, variable step attenuators for use from DC to 4500 mc with low VSWR and zero insertion loss. Similar to AW Series attenuators but designed for front-panel mounting.

TURRET ATTENUATORS

MICROLAB SERIES	AS	AT (2 watt)	AT (5 watt)	AT (15 watt)	AV	AW	AX
REQUENCY RANGE (kmc)	4-10	0-5	0-5	0-5	0-2	0-4.5	0-4.5
TTENUATION VALUES (db)	0-20	0-60	0-30	0-60	0-20(3)	0-30	0-30
AXIMUM VSWR	1.40	1.30	1.40	1.40	1.25	1.30	1.30
CCURACY (db) (1)	±0.5	±0.5	±0.5	±1.0	±0.7	±0.5	±0.5
OWER, AVERAGE (watts)	2	2	5	15	2	2	2
OWER, PEAK (kw)	2	2	3	3	1	2	2
VERALL LENGTH (in.) (2)	8.4	6.9	8.1	10.5	2.8	3.3	4.7
EIGHT (oz.) (2)	33	27	31	40	6.1	9.7	13.3
ETHOD OF ADJUSTMENT	knob	knob	knob	knob	(4)	(4)	knob
USH-PULL MOTION REQ'D	yes	yes	yes	yes	no	no	no
ANEL MOUNTING	yes	yes	yes	yes	no	no	yes
HASSIS MOUNTING	yes	yes	yes	yes	no	no	no
ATERPROOF	no	no	no	no	no	yes	yes
RICE (1) (2)	280.00	250.00	340.00	430.00	150.00	220.00	240.00

OTES: (1) 10 db nominal (2) Type N connectors (3) Per turret (4) Knurled finger grip on rotating tumbler

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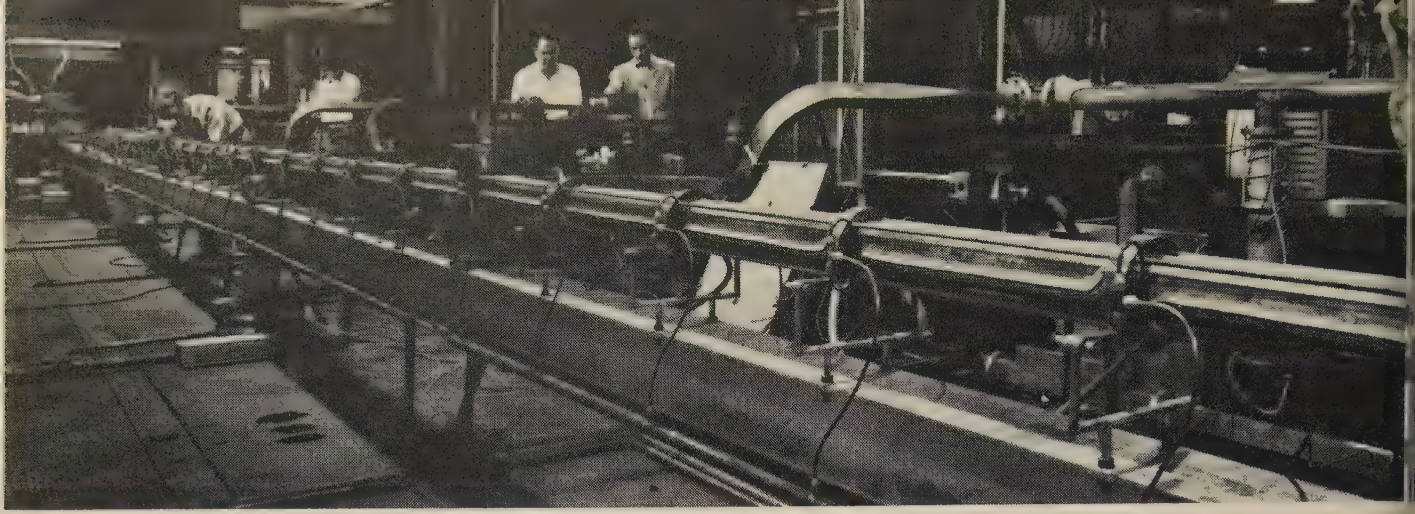

Stanford's Mark III linear electron accelerator, designed to exceed one Bev(billion electron volts).

Dr. Ginzton

(*Continued from page 32*)

He received the Bachelor of Science in Electrical Engineering degree from U. C. in 1936, after 3½ years, and stayed on an additional year to receive his Master's. A few months later he moved 40 miles down the San Francisco peninsula to Palo Alto where he accepted a teaching and research assistantship position at Stanford University, and continued his academic studies. The following year he was awarded the Electrical Engineering degree and embarked on a detailed study of stabilized negative impedances. This included an investigation of the properties of devices which could be made to exhibit negative resistance and an examination of some of the practical applications of these devices. The result of this work was made the subject of his doctoral dissertation, and for it he was awarded the Ph.D. degree in 1940.

The previous year, in addition to completing requirements for his Ph.D., Dr. Ginzton had started working with a group in the Stanford Physics Department which included Professor W. W. Hansen (a brilliant and inspiring teacher in whose memory the Stanford Microwave Laboratory is now named), Russel and Sigurd Varian, and Professor D. L. Webster. Readers of the *Microwave Journal* probably recognize that this group was working on development and applications of the klystron. Dr. Ginzton became an integral part of the team, and when the project was transferred to Sperry in 1940, he went with it. There, his unique combination of brilliant scientist plus able executive was quickly recognized, and in five years he rose from Assistant Project Engineer to be head of the Microwave Research and Tube Research Laboratories. His primary contributions at Sperry were in the field of doppler radar, microwave measurement technique, and klystron development.

After the war, Dr. Ginzton was offered the opportunity of returning to Stanford as assistant to Professor Hansen. He jumped at it and during the next three years he was instrumental in helping Professor Hansen organize the Stanford Microwave Laboratory. In 1949 he was appointed Professor of Electrical Engineering and Physics, and after the death of Professor Hansen the same year, Dr. Ginzton became Director of the Laboratory. Under his guidance the Laboratory has been extremely successful in the development of high power klystrons and has, in additio expanded its fields of interests to include broad studies o klystrons, high-power traveling-wave tubes, and other microwave power devices.

For most people these two jobs (Professor and La Director) would occupy full time, but Dr. Ginzton i apparently endowed with a rare combination of talent including almost inexhaustible energy, true brilliance i organization and administration, a driving, creative min and a quiet modest manner. These characteristics hav enabled him to carry on a number of jobs simultaneousl and achieve a high degree of success at each. Thus, whil active in the positions previously described, Dr. Ginzto retained his close association with the Varian brother played a key part in their planning of a new company an became a member of the Board of Directors when Varia Associates was formed in 1948. Other contributions t the company over the years have included membership o several policy and planning committees at the operatin level and consulting work. When Russell Varian died i August 1959, the company selected Dr. Ginzton to replace him as a Board Chairman, thereby indicating thei recognition of his tireless efforts.

As if all this weren't enough, Dr. Ginzton has, since hi return from a 13 month sabbatical in Geneva in 1957- spent a great deal of time planning a two-mile linea accelerator for Stanford. To date he has guided the design and construction of 10 linear accelerators there, including a billion electron-volt unit which is 220 feet long and a six million volt X-ray machine designed for cance therapy. The two-mile unit, designed Project "M," ha already received Presidential blessings and now await Congressional action in the form of authorization.*
Under the proposal, Project "M" would require six yea and $120 million to complete. Its 240 klystrons woul

(*Continued on page 37*)

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* In April Congress declined to authorize the project, bu appropriated about $3 million for further study. The reaso claimed for this action was that it would permit more accurat cost estimates to be obtained. Dr. Ginzton comments, "Ther was long debate in both houses, and no opposition was expressed whatever. I have complete confidence that the project will be approved."

Advanced microwave

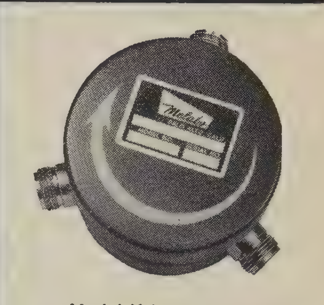
COMPONENTS from MELABS

seasoned microwave designers and builders

NEW! L Band and 400 MC Circulators

Model X-101A, L Band

Lightweight, compact 3-port circulators, 10% bandwidths. Conveniently separates input, output terminals of parametric amplifier to increase gain-bandwidth and stability.


Model X-127, 400 MC

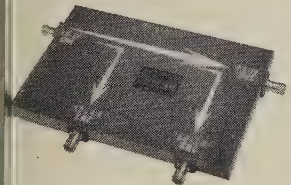
SPECIFICATIONS

Other models available with similar characteristics from 360 to 3000 MC; also tunable units to cover 25% bandwidth. Can also be supplied with electromagnet for high speed switching applications.

	Model X-101A	Model X-127
Frequency—fixed tuned:	1300 to 1500 MC	380 to 420 MC
Insertion loss:	1 db max.	1 db max.
at band center:	0.5 db max.	0.5 db max.
Isolation:	15 db min.	17 db min.
at band center:	20 db min.	24 db min.
VSWR:	1.3:1	1.3:1
at band center:	1.1:1	1.1:1
Size, including connectors:	3½" diam.	5½" diam.
Weight, approx.:	2 lbs.	4 lbs.
Price:	$400.00	$400.00

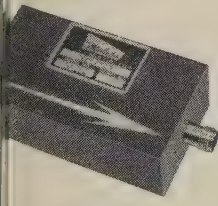
UNIQUE! Band separation filters.

Models X-121/122/123 three-port filters can separate the 1 to 12 KMC spectrum into octave bands. They permit two or more broadband receivers to be connected to a single very broadband antenna with a minimum insertion loss and high isolation between receivers. Two or more of the models can be combined as shown in the photo.

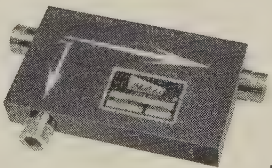


	Model X-121	Model X-122	Model X-123
Input frequency range	1 to 12 KMC	4 to 12 KMC	1 to 4 KMC
Output frequency ranges:	1 to 4 KMC 4 to 12 KMC	4 to 7.5 KMC 7.5 to 12 KMC	1 to 2 KMC 2 to 4 KMC

LUS these precision microwave components:



Melabs isolators include millimeter wave ferrite models, 66 to 73 KMC; miniaturized ferrite S-band isolators (only 3½" long, including connectors), 2,700 to 3,100 MC; resonance absorption radiometer and telemetry band devices, 1,330 to 2,360 MCS; broadband load isolators covering, collectively, 3.95 to 40.0 KMC without tuning.



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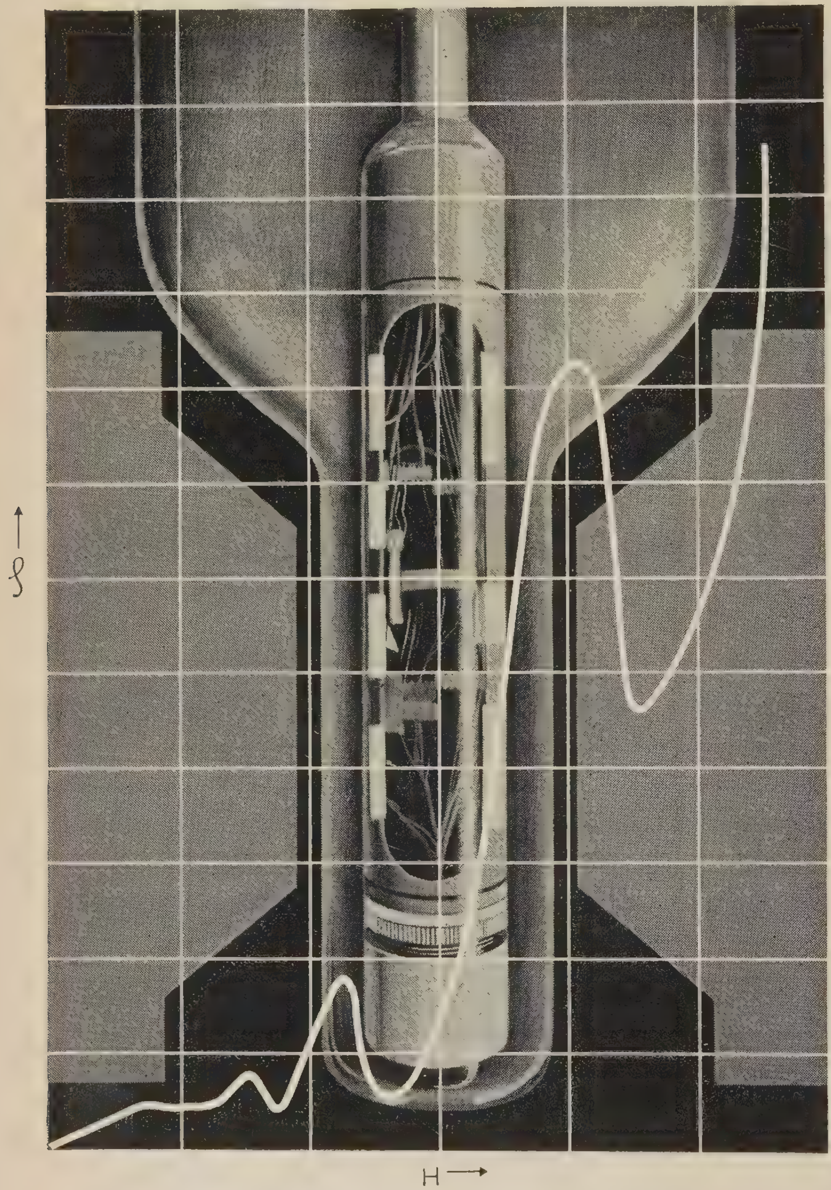
SOLID STATE ELECTRONICS



Observation of oscillatory behavior of magneto-resistance in semiconductors at low temperatures. This study of Landau levels in conduction or valence bands provides band structure information necessary to an understanding of transport properties.

At Lockheed Missiles and Space Division, solid state electronics encompasses a wide range of activities. Solid state physics conc itself with theoretical and experimental wo in the areas of paramagnetic resonance stu in solids; ferromagnetics and ferroelectrics; transport processes in solids; infrared spectroscopy; microwave properties of soli radiation effects in semiconductors; crystal growth; and other related topics.

In solid state devices, the basic work applie thermoelectric and radiant energy conversi evaluation of environmental effects; and th study of new components based on ferrites ferroelectrics, thin films, semiconductors, intermetallic compounds and other solid state materials.

Research in solid state circuits relates to ci aspects of novel solid state components an systems, such as in microsystem electronic in lumistor circuitry; and to unconventional of existing solid state devices.

Engineers and Scientists: Programs at Lockheed Missiles and Space Division rea far into the future and deal with unknown and challenging environments. If you are experienced in one of the above areas, or i related work, you are invited to join a com with an outstanding record of achievement make an important individual contribution to your country's scientific progress. Write Research and Development Staff, Dept. H 962 W. El Camino Real, Sunnyvale, Calif U.S. citizenship or existing Department of Defense industrial security clearance requi

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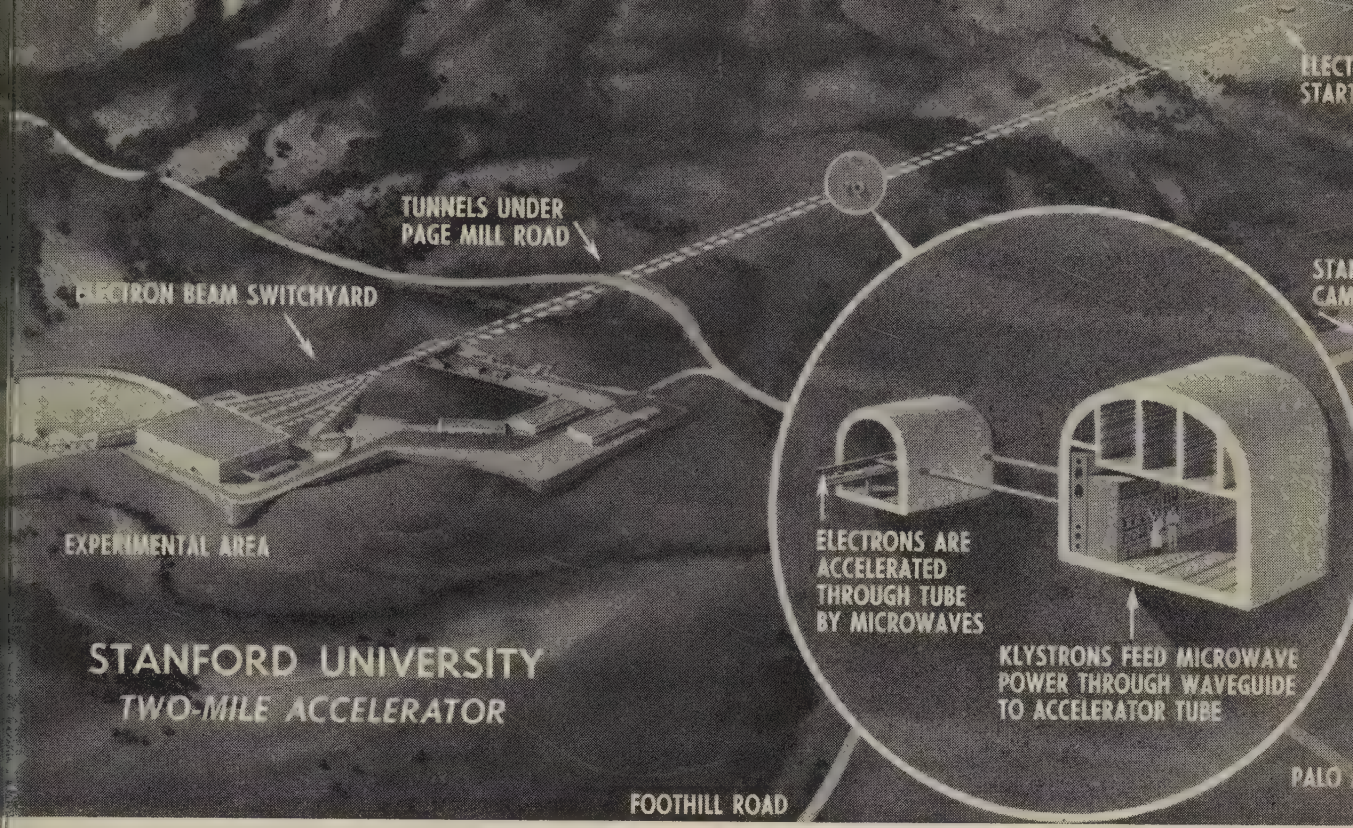
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One of the proposed sites on the Stanford campus for the two mile accelerator.

Ginzton

(*Continued from page 34*)

de a maximum beam energy of about 20 billion elec- volts with an average beam current of 30 micro- res, making it by far the most important tool for energy particle physics research in the world. (A an proton accelerating synchrotron known to be in lanning stage is believed to have an objective of 50 beam energy but only 0.001 microamperes average current.)

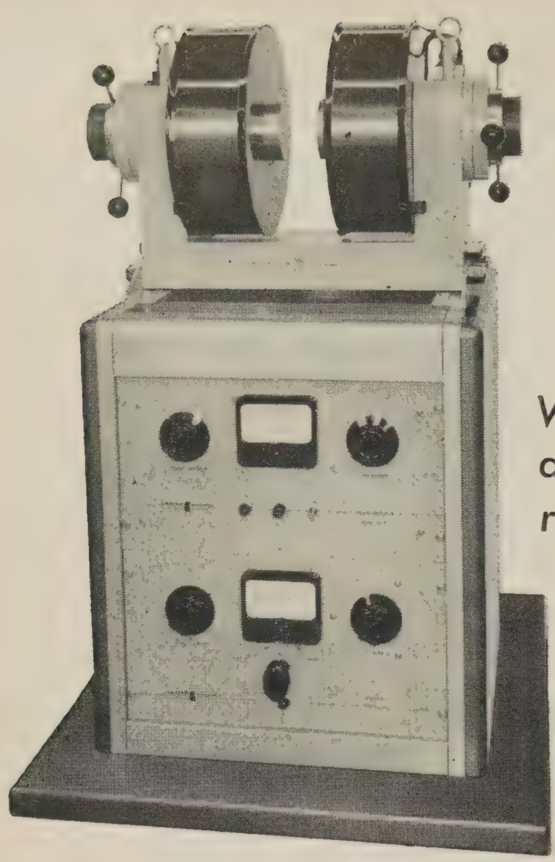
testimony before Congress Dr. Leland Haworth, Di- r of the Brookhaven National Laboratory, referred to ct "M" as a matter of "transcendent importance in cientific program." His enthusiasm is understandable, he research carried out with such a tool could affect very foundations of currently accepted principles of ics. For example, Dr. Haworth points out that at the short distances involved in the nuclear experiments possible that the laws of quantum electro-dynamics be altered or even fail completely, and that under in circumstances a radical revision of our concept of itself might be necessitated. In any case, it is cer- that the accelerator would add greatly to the knowl- and understanding of the 30 particles and anti- cles believed to exist. (Some of the heavier anti- cles, predicted theoretically, cannot be observed rimentally without a high-energy accelerator.) Dr. ton calls the pursuit of such understanding "one of most important and challenging tasks facing physicists e present time."

is to this project that Dr. Ginzton proposed to de- a major portion of his time for the next six years. resigned as Director of the Microwave Laboratory in mber 1959 in order to be able to devote more time to this and to his position at Varian.) Even more important to Dr. Ginzton personally is the fact that he will be the administrative leader on Project "M" and will make virtually no scientific contribution. "This may mean," he says "that I may never come back to science." He feels very strongly, however, that the administration is a vital service to the scientific community, and certainly it is to be expected that this vital program would benefit greatly from his executive skill, scientific knowledge and accelerator experience. Fortunately, Dr. Ginzton, unlike most creative scientists, is just as happy in the function of executive as he is when he's doing the research himself.

He belittles his technical achievements, which include 50 patents, 30 technical articles and papers, a textbook entitled "Microwave Measurements," and the high power klystron development work. "These don't amount to a hill of beans," he says. The IRE disagrees. In 1951 they made Dr. Ginzton a fellow of the organization and in 1958 they awarded him the Morris Liebmann Memorial Prize "For his creative contribution to the generation and useful application of high energy at microwave frequencies." ("A team effort," he protests. "My name somehow got linked with the project.")

Dr. Ginzton feels that his major contribution, from his early work at Sperry through his present efforts at Varian and Stanford, has been his ability to mold a group of talented individuals into a smoothly functioning, highly productive unit. Certainly, his talent for getting along with people and overcoming conflicts has played a key part in making this possible. The devotion of his associates and staff is summed up in the words of his secretary at Stanford, Mrs. Dorothy McIntosh, who said, "He's a peach." It's not the way we would have said it, but it tells the whole story.

(*Continued on page 38*)



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Dr. Ginzton

(*Continued from page 37*)

NOTES FROM A WRITER'S DIARY

Dec. 20. Phone call from Gersh Wheeler saying to do biography of Dr. Ginzton for *microwave journal.*

Dec. 21. Phone call from Gersh Wheeler saying not to contact Dr. G. until *journal* publisher gets G's approval.

Jan. 5. Recover from holiday festivities (next year I'll have a quiet celebration) to focus on copy of letter from publisher to Gersh saying O.K. to interview Dr. G.

Jan. 11. Call Dr. G at Stanford. Told he's at Varian. Call Varian. He's on his way back to Stanford. Give up.

Jan. 12, AM. Call Dr. G at Varian. Not there. Leave message for him to call. Call Stanford. There. But in meeting. Leave message for him to call.

PM — Success! Interview set for 3 pm tomorrow.

Jan. 13. Lost as usual, so get unexpected drive around Stanford campus. Spanish-style building attractive from distance, ancient and grim close up. Finally locate low, long Microwave Lab. On time since anticipated getting lost, left early. Meet Dr., take furious notes.

Feb. 10. Wire from publisher saying where in blazes is Ginzton biog? Wire back (collect) promising to get right on it.

FINAL DIARY ENTRY

Feb. 18. Finish article and start final typing. Open mail, find letter from publisher saying article postponed to WESCON issue, so no need to hurry. A pox on publishers!

PAPERS

We wish to emphasize again that "the journal" is interested in receiving papers from the industry.

Papers can be addressed to:

"the microwave journal," 1330 Beacon St., Brookline, Mass.

In the West Coast Area please address all papers to:

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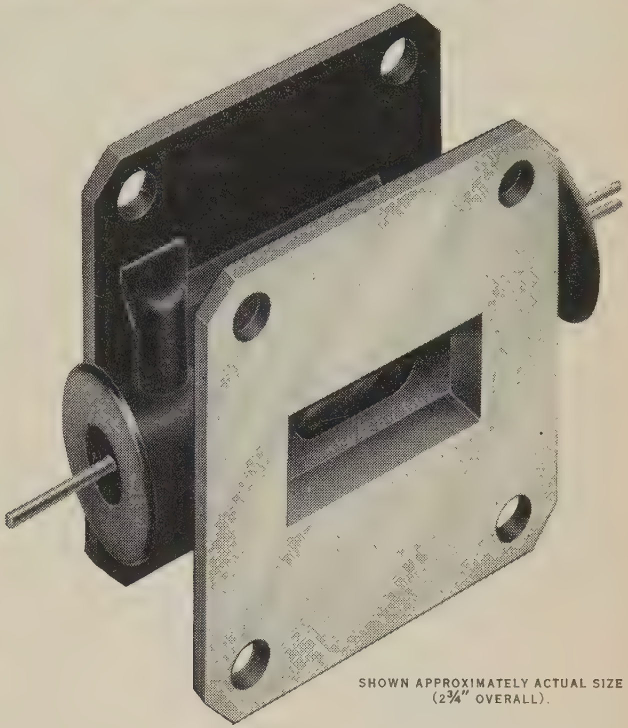

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	IcLM3	IcSM2
Frequency range	*1,250-1,600 mc*	*2,000-4,000 mc*
Isolation		
Minimum	*20 db*	*20 db*
Maximum	*40 db*	*31 db*
Insertion loss		
Minimum	*.8 db*	*1.3 db*
Maximum	*1.0 db*	*2.0 db**
Power		
Peak	*10 kw*	*5 kw*
Average	*25 watts*	*5 watts*
VSWR		
Minimum	*1.10*	*1.02*
Maximum	*1.25*	*1.25*
Weight (max.)	*3.8 lbs.*	*2.25 lbs.*
Max. dimension	*12 in.*	*9.8 in.*
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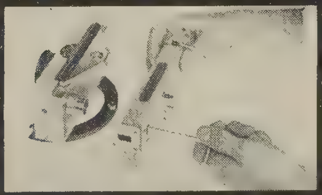

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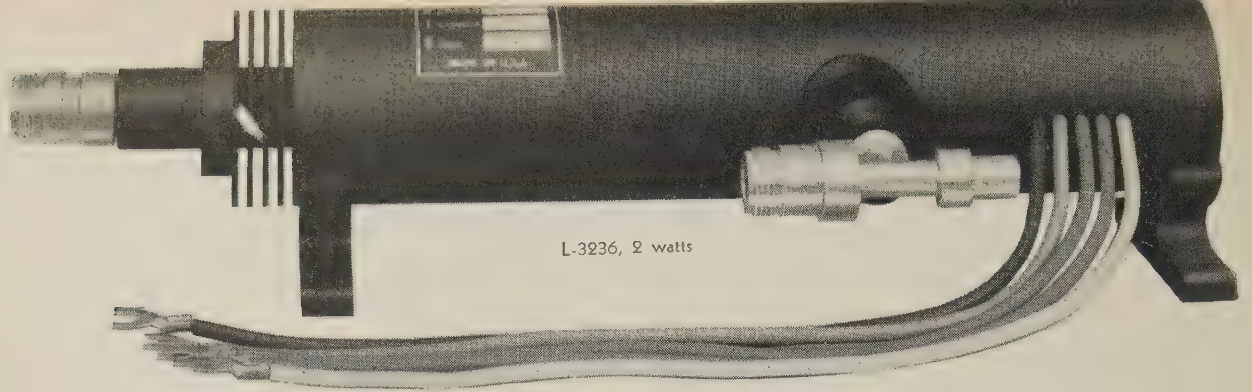
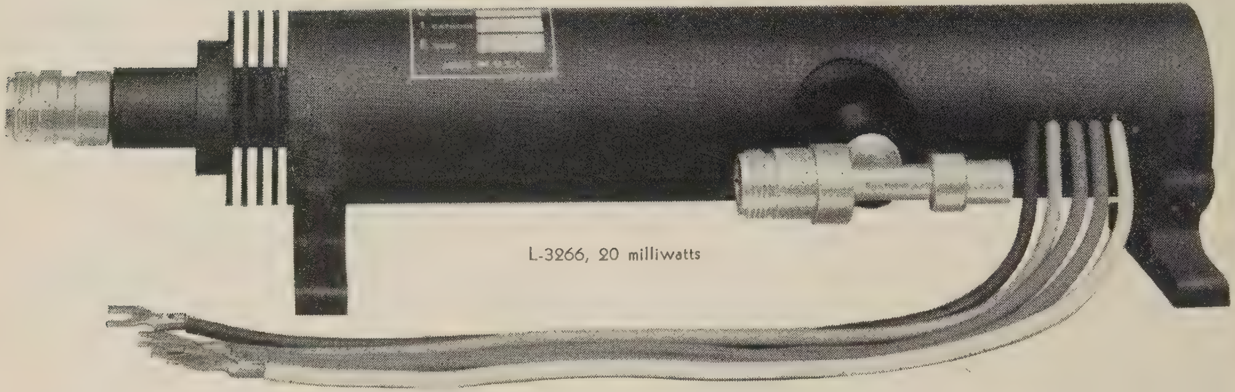


L-3236, 2 watts

TWTWINS



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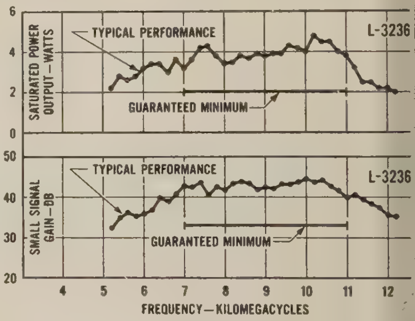

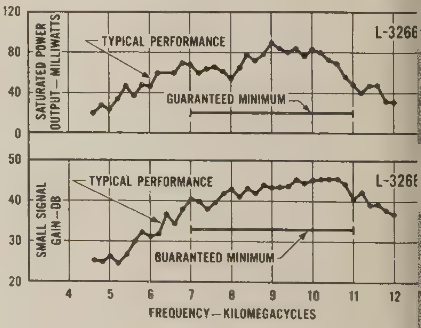

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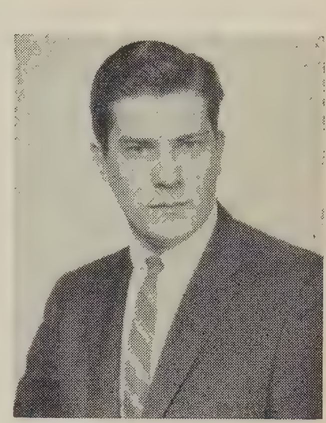
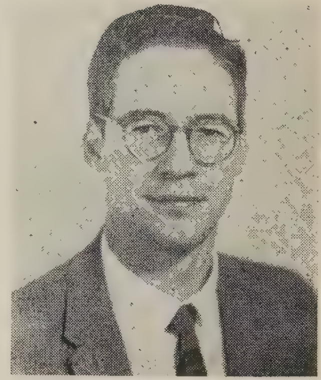
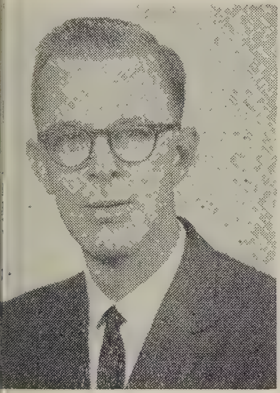


NHARD D. BAARS was born in Marburg, Germany, on December 15, 1934.
eceived his BSEE degree from Newark College of Engineering and is currently
g graduate work there.
Mr. Baars is employed by Frequency Standards, Asbury Park, N.J., where he
spent several years in the design and development of microwave components,
icularly tunable and fixed tuned multi-section microwave filters.
Recently, he has joined the company's Sales Department as Field Application
ineer, in which position he is responsible for sales of a developmental nature
customer service.
Mr. Baars is a member of the IRE, Eta Kappa Nu, and Ometron Delta Kappa.



ERT M. HILL received a BA degree in physics from Cornell University in
and a PhD degree in physics from Duke University in 1953. His thesis,
rowave Spectrum of Oxygen," was done under Walter Gordy. Since joining
ania in 1953 he has done research in plasma and solid state physics. He is a
ber of Sigma Xi and American Physical Society.



GEORGE R. HUARD, JR. was born in Detroit, Michigan, June 26, 1924. He received his education at the University of Detroit and Wayne University.

For 2½ years he was employed by the Fisher Body Division of General Motors. Thereafter, he joined Reynolds Metals Co., Phoenix, Arizona, in the die design department. In 1950 he joined the mechanical design staff of Motorola Research Inc., Phoenix, and was engaged in electronic packaging and semi-conductor manufacture equipment design. He came to Sylvania, Mountain View, California, in 1954 as designer in the microwave antenna division. He then transferred to the Sylvania Microwave Physics Laboratory for design duties in ferrite devices and plasma research equipment.

He is the holder of two patents and has contributed to "Machine Design" magazine.

DR. MALCOLM W. P. STRANDBERG, professor of physics at MIT, is a noted authority on microwave spectroscopy.

Dr. Strandberg received his BS degree from Harvard University in 1941 and his PhD degree from MIT in 1948. From 1941 to 1945 he was a staff member of the MIT Radiation Laboratory. Dr. Strandberg spent the year 1942 to 1943 in England as a visiting scientist working on radar countermeasures. A research assistant in physics from 1945 to 1948, he was appointed assistant professor of physics in 1948, associate professor in 1953, and professor of physics in 1960.

He is head of a research group in microwave spectroscopy at MIT and has published extensively in this field.

Dr. Strandberg is a fellow of the American Physical Society, American Academy of Arts and Sciences, the New York Academy of Arts and Sciences, the American Association for the Advancement of Science, and a Visiting Scientist for American Institute of Physics. He is a member of Phi Beta Kappa and a fellow of the IRE.

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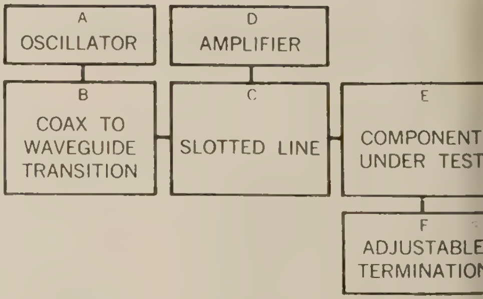

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PRECISE SPECIFICATION OF A FREQUENCY*

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here are increasingly many instances of microwave in- nentation which require the use of frequency-stable rons. The obvious uses are in MTI instrumentation re one is interested in phase coherence of radar signals hence is required to work with a local oscillator which a low frequency drift or high frequency stability so , between radar pulses, a negligible amount of phase t is introduced into the i.f. signal due to local os- tor frequency drift. Other obvious applications are measurements on high Q or narrow band-pass systems 1 as sharply tuned cavities or even atomic frequency rence resonances such as the cesium atomic resonance the ammonia molecular resonance or even in cavity- paramagnetic resonance spectrometers where high quency-stability is required for high sensitivity. Less ious uses of klystrons with high frequency-stability ild be in ordinary microwave measurements where high quency-stability allows one to make measurements of h voltage-standing-wave ratios with greater precision. e may also be interested in long term frequency sta- ty so that measurements of an rf structure, which re- re a good part of the day to carry out, may be made r one measurement of the frequency of the radiation rce. In this case, one generally obtains short-term sta- ity much better than is needed for the measurements at nd as a by-product of having achieved long-term fre- ency-stability.

The matter of defining the frequency stability of a stron for these applications is a complicated one and, we discuss at length below, requires, in fact, a des- ption of the spectrum of the signal source itself, rather n the statement of a single number for the precision of a source such as, one part in 10^8. Although the problem is generally side-stepped, there is, indeed, a good deal of complication involved in describing the spectrum of an unstabilized klystron also. Thus, one conventionally states the results of measurements on a microwave system in terms of the source frequency, although it is well-known that any known microwave source has a certain bandwidth over which it emits radiation at any time; hence, even an unstabilized klystron must be described in terms of its output spectrum. The actual output power spectrum may be shown as in Figure 1. The main power output is within a band of width, $\triangle\nu$, with a low output of power over a broadband B, which is the frequency width of the matching network coupling the output line to the elec-

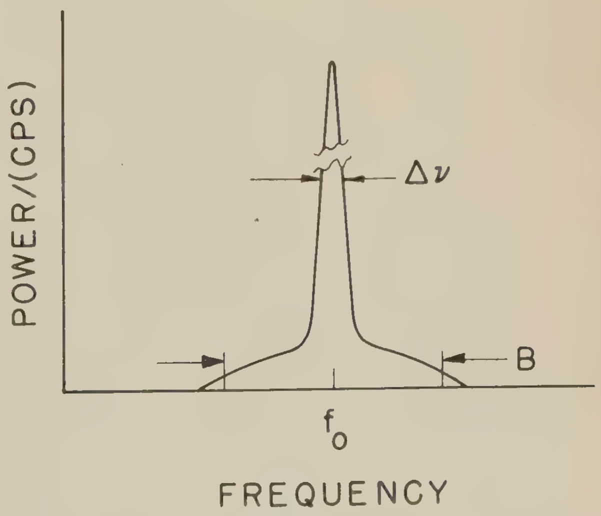


Figure 1 — Oscillator natural output power spectrum.

Vork sponsored by Strand Labs., Inc., 294 Centre Street, wton, Massachusetts.

tron beam. The broad band would commonly be called the tube noise output, and the narrow intense band would be called the cw output carrier, modified or degraded by hum and drift resulting from an unregulated and poorly filtered klystron power supply. The fact is, however, that even if the power supply is perfect, the power output will not be a single frequency but a band of frequencies — a few kc wide at 10 kmc, for example.[1] Of course, a carrier modulated with a frequency 3 x 10^6 smaller than the actual carrier frequency will appear to be a single frequency or will be measured as a single wavelength with measuring equipment that has a resolution of less than one part in 10^6. With greater resolution — for example, that obtained by homodyning the radiation against itself delayed by a time τ — the klystron output will be shown to be incoherent if, for example, τ exceeds a few milliseconds.

The solution, then, if one wants the klystron output to be a single frequency, is to improve on Nature by frequency-stabilizing or phase-stabilizing the klystron output to some frequency standard — a resonant cavity or a purer carrier. Suppose then, that a frequency stabilization system is connected to the klystron; for example, a balanced discriminator that tends to hold the klystron frequency to the zero susceptance point of a resonant cavity. As the feedback gain is increased in the frequency stabilization loop, the klystron frequency will more nearly correspond to the cavity zero-susceptance frequency. The spectrum of the klystron output will apparently narrow, and with sufficient gain it should correspond to an output spectrum of infinitely narrow width at the cavity-determined frequency. Actually, the stabilization process is not quite so simple because the stabilization process trades a decrease in main spectrum width for an increase in the broad spectrum noise background arising from unavoidable noise introduced through the stabilization circuit. Consider also the fact that much of the noise will be due to 60 cycle modulation components. Thus, with increasing feedback gain, the 60 cycle modulation the carrier output will diminish but will not vanish e cept in the unachievable limit of infinite feedback gai

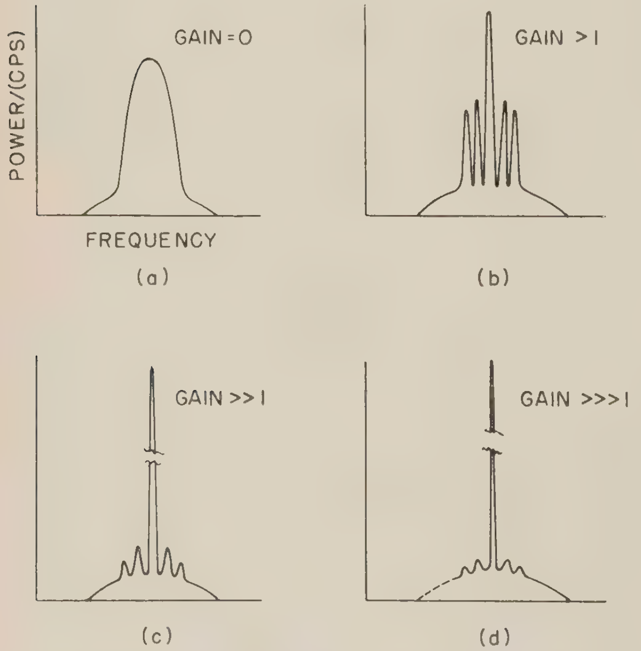


Figure 2 — Stabilized klystron power spectrum with increasing stabilization gain, a through d.

The sequence of events that occur as feedback is a plied to a klystron oscillator is indicated in Figure 2. A the feedback gain is increased, the spectral width na rows by diminishing the amplitude of the hum and noi components in the spectrum near the precise carrier fr quency. At some point the feedback gain is great enoug to resolve the spectrum of the klystron into a carrier wit a broad and reasonably large incoherent noise backgroun plus the coherent sidebands at 60 cycles and harmonics c 60 cycles away from the carrier frequency. The 60 cycl components exist on the klystron output, since the klystron exists in a sea of 60 cycle modulated electric an magnetic fields. It is precisely at this point, the poi where the spectrum can be viewed as a resolved spectru of carrier and 60 cycle sidebands, that the real paradox i defining a frequency and the stability of that frequenc occurs. As long as there is any 60 cycle variation in th frequency to be corrected, it is obviously impossible t narrow the klystron spectrum to less than 60 cycles. Thi is the result of the simple fact that a 60 cycle modulate carrier must be expressible in terms of a carrier plus side bands at the harmonics of the modulating frequency. A klystron, highly stabilized as to its carrier frequency bu with 60 cycle sidebands in its spectrum, could from on point of view never be considered to have a stabilit greater than 60 cycles at the actual carrier frequency. Increasing the feedback stabilization will not remove thes 60 cycle sidebands; it will only diminish them in amplitude. Although these 60 cycle sidebands are reduced to any amount with respect to the carrier — fo example, 120 db below the carrier — the measuremen of frequency alone will indicate that in the klystron output there exist frequencies deviating from the carrier by ± 60 cycles, and hence, one might be led to the conclusion that this was the limiting stability of the oscillator. Actually such a conclusion is pointless because i makes no distinction between an oscillator that has large-amplitude, 60 cycle components or small amplitude, 60 cycle components. The crucial thing to be considered is not the actual spectral width, which, as we have seen, will always have some finite value, but the ratio of the energy in the so-called carrier to the energy in the noise and hum sidebands. Such a specification of klystron stability will actually be a specification of the klystron output spectrum and is the only generally meaningful description that can be given of a stabilized klystron.

From this point of view, one would be led to the following prescription for defining the stability or frequency of high-stability oscillators:

1. The *short period drift of the carrier frequency* ca be measured and defined as a variance, or as a rate; that is either as the limiting drift frequency — the amount of drif of the carrier in cycles per second which one has a prob ability of less than ½ of measuring in a given observation period — or the drift of the carrier in terms of the cps per second if the coherent drifts are predominant.

The residual frequency fluctuations caused by noise l hum will cover, certainly, a broad frequency band, sumably of the order of a mc or more, but such a ctrum would be characterized by the total amount of ctromagnetic energy that exists away from the carrier. other words, *this sideband power is described by stat- the number of decibels below carrier that it is mea- ed to be and the frequency width that this dominant eband power occupies.* From this point of view, mea- ements of the spectral width alone are quite meaning- s because they do not adequately describe the actual stron spectrum.

A further reason that makes our method of defining stability of a klystron a worthwhile operating charac- ization is that these parameters for a klystron stability measured quite easily. It turns out that one can build gh-Q triode oscillators which can be shielded from ther- l drifts and extraneous frequency modulation. Such cillators can be used as a reference stalo so that carrier the stabilized klystron can be separated from its noise ckground. For example, a stalo oscillator at L-band or band can be multiplied to X-band in a silicon crystal, d the beat frequency between the harmonic of this low- quency stalo with the X-band klystron can be pre- nted on an oscilloscope. When the two oscillators are at entially the same frequency (homodyning), the car- r can be separated from the high-frequency noise com- nents by using a simple RC high-pass filter to reject the rier. The total rms voltage in the sidebands can then measured with an rms voltmeter (Figure 3a). Analyti- y this reading will be

$$\left((V_N) \right)_{rms} = \left[\left(\sum v_n \right)^2 \right]^{1/2} \qquad (1)$$

ere the v_n are the noise sideband voltages. If the uare is multiplied out we obtain

$$\left((V_N) \right)_{rms.} = \left[\sum v^2_n + \sum_m \sum_{n \neq m} v_n \quad v_m \right]^{1/2} \qquad (2)$$

nce v_n and v_m are incoherent the double sum will aver- e to zero and we obtain the desired result:

$$\left((V_N) \right)_{rms} = \left[\sum v^2_n \right]^{1/2} \qquad (3)$$

e low frequency stalo is now tuned so that its har- onics produce a finite beat note with the stabilized kly- on output (Figure 3b). The carrier signal will now be ssed by the RC filter and the rms voltmeter will read e rms value of carrier plus background noise voltage. nce an rms meter is used to measure the beat voltage d since the carrier beat note is uncorrelated with the ckground noise signal, then, using the same arguments ployed in obtaining Equation 3, we may say that the tio of the square of these two meter readings will give e ratio of the carrier plus noise power to noise power. rther, a simple RC low-pass filter can be used in con- nction with the noise background potential measurement determine the frequency width of the noise (Figure 4).

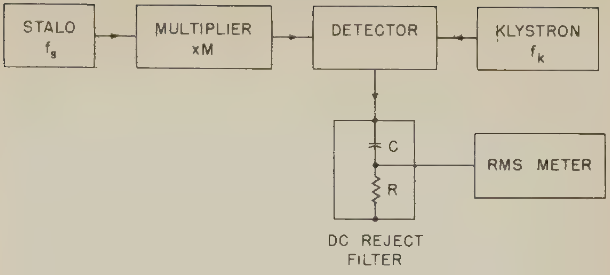


Figure 3 — Block diagram of apparatus to measure the ratio of carrier power to sideband power.

The high-frequency cutoff of the R'C' filter can be varied until the rms noise voltage has been reduced to 0.707 of its unlimited band value. The R'C' time-constant will then give the frequency width of the noise spectrum as $\triangle f = 4$ R'C')$^{-1}$.

Finally, the carrier beat frequency with a frequency source of long-term stability can be measured to determine the long-term frequency drift of the klystron carrier; for example, its drift over a period of several hours. Two types of long-term drift can again be considered. One would be coherent drift that is given rise to by changes in temperature, humidity, barometric pressure, and so forth, and will change the characteristics of the frequency reference to which the klystron is stabilized. There are also possible drifts in the stabilization circuitry itself which will probably be incoherent drifts and should be unrelated in several identically stabilized oscillators, whereas the coherent drifts due to temperature and humidity would, presumably, be correlated between several identically stabilized oscillators. Thus, a stable frequency at X-band which is derived from the low-frequency crystal and multiplier chain, or the like, can be used to obtain a beat note with the klystron, from which the total long-term stability can be measured. The incoherent drifts can be determined by measuring the fluctuation in the beat note between two identically stabilized klystrons.

Scope photographs that illustrate the measurements described here are instructive. These pictures were obtained by using a Strand Labs Model 500 Stabilized X-band Klystron and a 5 mc quartz oscillator as a frequency reference. Figure 5 shows the beat note that is obtained between the 1800th harmonic of the crystal oscillator and the stabilized X-band oscillator, when they are homo-

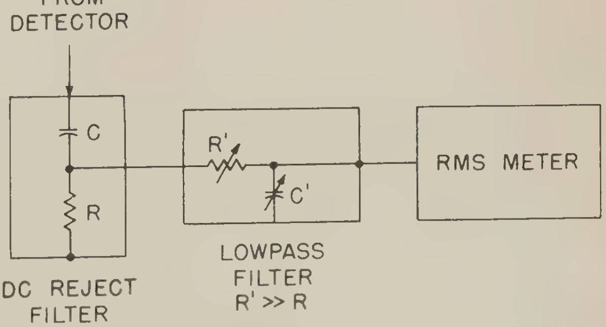


Figure 4 — Circuit required in addition to Figure 3 to measure sideband power spectral width.

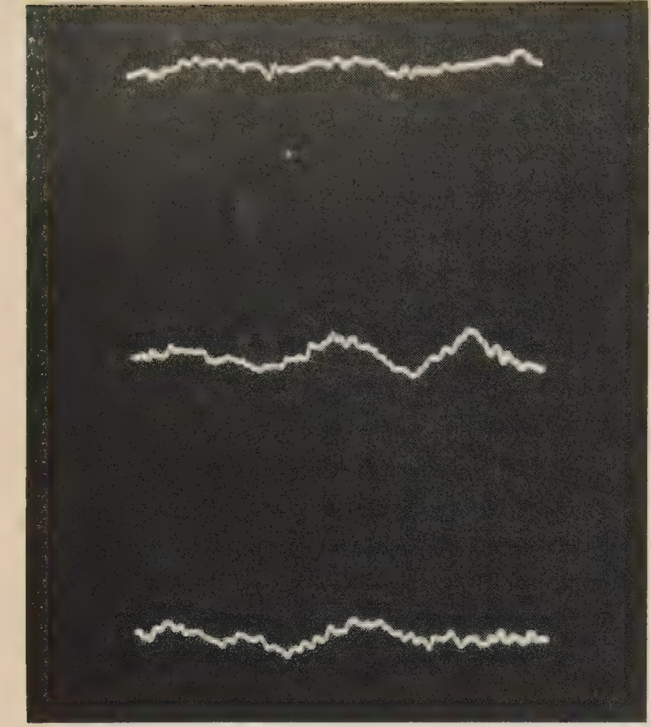


Figure 5 — Oscilloscope presentation of the noise sideband potential. (Standard and stabilized klystron homodyning.) Sweep length 10^{-2} seconds. Gain the same as Figure 6.

dyning, or when the beat note is essentially zero. In Figure 6 the stalo has been tuned a slight amount so that the beat note shown on the scope trace is passed by the RC filter. The ratio of the rms voltage is 10. The frequency width of the noise beat note spectrum, $\triangle f$, is determined to be 10^3cps. This means, as is shown in the appendix, that the mean modulation index is equal to $(V_N/V_s)(2f_0/\triangle f)^{1/2} = 0.035$. This means that the maximum frequency deviation F_{max} is equal to the mean modulation index multiplied by the maximum significant frequency, $\triangle f$, which in this case is 35 cps. This indicates a short time stability of less than three parts in 10^9.

In the introduction to this paper a good deal of fuss was made about the need for a more sophisticated specification of a klystron frequency. It is hoped that the discussion has made it quite clear that a klystron does not have a "frequency" but that it has a spectrum and that this spectrum must be described by some useful parameters in order to characterize the actual operation or characteristics of a klystron from a frequency point of view.

Appendix

We wish to consider a klystron carrier that is modulated in frequency in a complex fashion. We write the rf voltage

$$V = V_0 \sin\left[\omega_c t + \int \omega(t)\, dt\right] \qquad (1)$$

where ω_c is the carrier frequency and $\omega(t)$ is the time-varying frequency contribution to the phase, the time integral over this component giving the actual phase of the rf field. When there are many components contributing $\omega(t)$ we may write it as

$$\omega(t) = \sum_{n=1}^{N} 2\pi F_n \cos(\Omega_n t - \phi_n) \qquad (2$$

Where F_n is the frequency deviation that arises from modulation frequency Ω_n, and ϕ_n is the phase of th modulation frequency. The integral over time, then, e presses the time dependence of the phase of the carrier follows:

$$\phi(t) = \int \omega(t)\, dt = \sum_{n=1}^{N} \frac{2\pi F_n}{\Omega_n} \sin(\Omega_n t - \phi_n) \qquad (3$$

The factor $2\pi F_n/\Omega_n$ is called the modulation index, an we shall write it as β_n.

$$\beta_n = \frac{2\pi F_n}{\Omega_n} \qquad (4$$

The rf potential may now be expanded in a Bessel seri expansion, and as Crosby[2] has indicated the resulting ca rier is a product of the zero-order Bessel functions ha ing as an argument the modulation index for each of th N particular frequencies. The m^{th} sideband of the n^t frequency is the same as if one has only one tone avai able with an amplitude that is proportional to the m^t order Bessel function of the β_n multiplied by a product

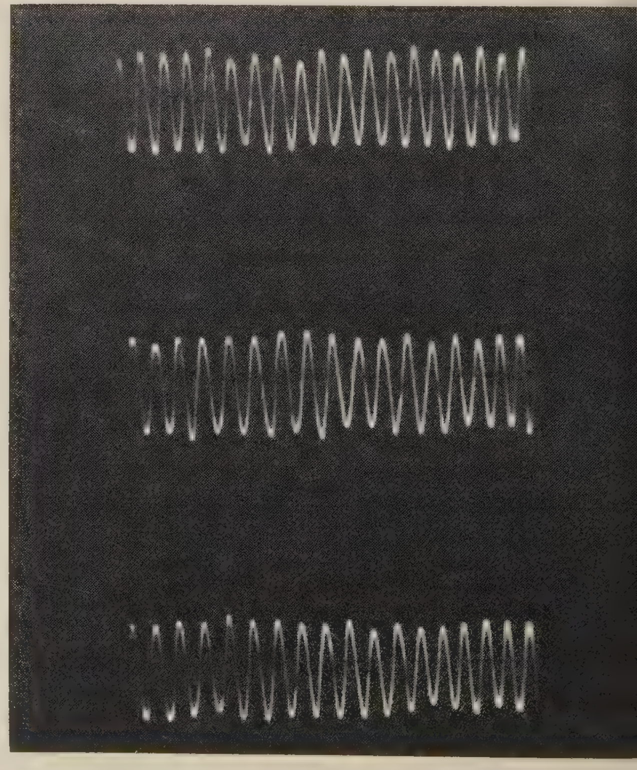
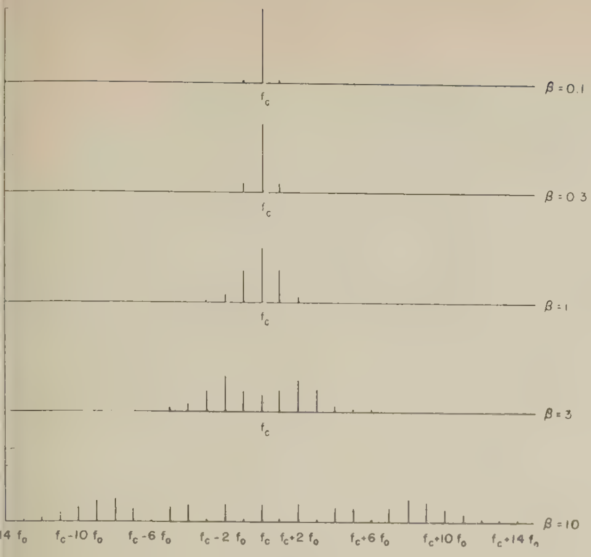


Figure 6 — Oscilloscope presentation of the carrier beat not (Standard and stabilized klystron heterodyning.) Swee length 10^{-2} seconds. Gain the same as Figure 5.



ure 7 — Voltage spectrum of a frequency modulated carrier f_c, with a modulation frequency f_o and various modulation indices, β.

-order Bessel functions having as arguments the modu- on index of the other tones. Additional cross tones r which are cross products of these spectral components which contribute to the density of spectral components which do not contribute appreciably to the spectral h. The result is: for large modulation index, the gy is distributed more or less uniformly in a band ng a width of twice the frequency deviation F_n, and small modulation index, the energy is concentrated in and about the carrier having a width of twice the imum modulation frequency.

As is well known from feed back theory, the process of quency stabilization then reduces the modulation index ociated with the frequencies, Ω_n, in proportion to the or

$$\frac{1}{1-\mu(\Omega_n)} \tag{5}$$

ere $\mu(\Omega_n)$ is the complex gain at the frequency Ω_n. quency stabilization then has the effect of reducing the dulation index for the N frequencies Ω_n and as the n increases a point will be reached where the modula- n index is small compared with 1. Figure 7 indicates effect of reducing the modulation index for a single e from a value of $\beta_n = 10$ to a value $\beta_n = 0.1$. It l be noted that as the modulation index is reduced the quency spectrum is reduced only to a frequency width π, no matter how small the actual modulation index is de. The carrier amplitude, given by the zero-order sel function of β_n approaches one as β_n approaches o. At one point at which the carrier can be differen- ed from the sideband components — in other words, ere the carrier amplitude is the factor of two or so ater than the dominant sideband components — we l that the only effect of reducing modulation index ther is to reduce the energy in the sideband spectrum. the limit of high feedback gain, the major contribu- n, to the klystron frequency modulation will arise from 60 cycle sidebands and the harmonics of 60 cycle sidebands. The power spectrum of a stabilized klystron will thus have sideband frequencies of nf_o, where f_o is the fundamental perturbing frequency. If the power spectrum has a width $\triangle f$ then we can say that

$$\triangle f = Nf_o. \tag{6}$$

It can be shown that the power in any sideband relative to the carrier for small modulation index is given as

$$\frac{P(\Omega_n)_{\text{sideband}}}{P_{\text{carrier}}} = \tfrac{1}{4}\,\beta^2_n \tag{7}$$

Since both upper and lower sideband will exist at frequencies $\pm\,\Omega_n/2\pi$ about the carrier, then with a more or less uniform noise spectrum containing N sidebands on one side of the carrier we can say:

$$\sum_{n=1}^{N} \frac{P(\Omega_n)_{\text{sideband}}}{P_{\text{carrier}}} = \frac{N\beta^2_n}{2} \tag{8}$$

But by measuring the voltages with the stalo homodyning and heterodyning and taking the ratio of these voltages we have measured the square root of the left-hand side of Equation 8 and hence are in a position to evaluate the mean modulation index:

$$\frac{V_{\text{sideband}}}{V_{\text{carrier}}} = \beta_n \sqrt{\frac{N}{2}} = \frac{2\pi F_n}{\Omega_n}\sqrt{\frac{\triangle f}{2f_o}} \tag{9}$$

However, we note that if the maximum modulation frequency Ω_N is equal to $2\pi\triangle f$ we may write the maximum frequency deviation in the form:

$$F_{\max} = \frac{V_{\text{sideband}}}{V_{\text{carrier}}}\sqrt{2\ \triangle f\ f_o} \tag{10}$$

In the example given in the text the voltage ratio was 10, the bandwidth $\triangle f$ was 10^3 and f_o was essentially 60 cps. This means that the maximum frequency deviation is given as 35 cps.

For frequencies greater than $\triangle f$, the contribution to the noise spectrum can be considered negligible and for frequencies less than $\triangle f$, the frequency deviation is given simply as

$$F_f = \frac{f}{\triangle f}\,F_{\max} \tag{11}$$

where F_f is the frequency deviation at the frequency f, and the other quantities have their usual meaning.

From the discussion and calculations given above it seems that the prescription of defining the total sideband power to carrier power ratio and the significant width of the sideband power, $\triangle f$, are sufficient for characterizing most klystrons as to their short-term or instantaneous frequency stability. Measurements that must be made by comparing the klystron frequency with an oscillator that has a long-term stability need then only characterize the maximum deviation of the klystron carrier frequency or its maximum drift in megacycles per hour, and so forth. The actual method of characterizing the long-term stability of the oscillator will depend upon whether the cavity, or frequency reference, itself has long-term stability or whether it depends upon the ambient temperature and humidity in such a way that long-term drifts in the reference frequency can be expected.

It is also evident from the form of the spectrum that one can obtain a reading that gives directly the mean-square-frequency deviation by a circuit as suggested in Figure 8. In homodyne operation, instead of going directly to an rms meter, one takes the sideband signals through a filter whose response is proportional to the frequency. Each component of the sideband signal, which is proportional to the modulation index when multiplied by the frequency, will give a contribution proportional to the frequency deviation. This means that the output of the f filter will be proportional to

$$f \frac{V_{\text{sideband}}}{V_{\text{carrier}}} = \sum_{n} \frac{1}{2} F_n$$

since, by taking the square root of Equation 7 and summing over all sideband components, we have:

$$\frac{V_{\text{sideband}}}{V_{\text{carrier}}} = \sum_{n=1}^{N} \frac{1}{2} \beta_n = \sum_{n=1}^{N} \frac{1}{2} \frac{F_n}{f_n} \text{ with } f_n = \Omega_n/2\pi \qquad (12$$

If this signal is now read with an rms meter, the meter reading will be proportional to the rms value of the frequency deviation because the sidebands are incoherent. In homodyne operation the upper and lower sidebands

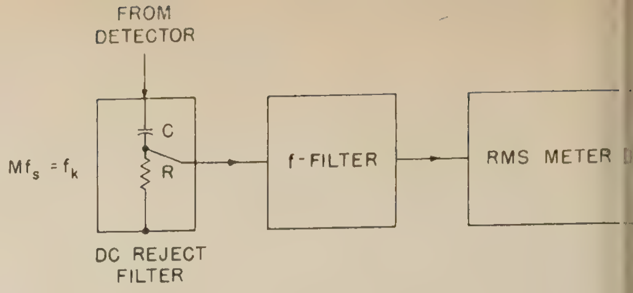


Figure 8 — Modification of block diagram of Figure 3 measure mean square frequency deviation directly.

will interfere constructively, so that the rms sideba voltage is given by

$$\left[\left(f \frac{V_{\text{sideband}}}{V_{\text{carrier}}}\right)^2\right]^{1/2} = \frac{1}{2}\left[\sum_{n=1}^{N} F^2{}_n\right]^{1/2} \qquad (1$$

The design of a filter with a response proportional frequency is not difficult, and quite possibly this techniq used in the Strand Labs. Model 950 Stalo Checker, is t simplest one for obtaining directly a reading of the r frequency deviation for a stabilized klystron.

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MICROWAVE SPECTROSCOPY

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Mountain View • California

Probably the best known and most dramatic use of the crowave spectra of molecules has been the ammonia iser which was developed under the guidance of Pro-ssor C. H. Townes of Columbia University. This device capable of amplifying with extremely low noise tem-rature and of producing oscillations which are stable to e part in 10^{12}. It is one of the outgrowths of a large dy of research on the structure of molecules by micro-ve spectroscopy.

Spectroscopy, or the study of the electromagnetic energy sorbed or emitted by molecules, has been one of the imary methods used by physicists and chemists for the udy of atomic and molecular structure. Since the end of orld War II, microwave frequencies and techniques ve been employed in increasing amounts because of the undant and very accurate information they provide.

When a molecule absorbs or emits a quantum, the ergy of the molecule must change corresponding to the ergy of the quantum. The process of this absorption or nission is governed by the equations of quantum me-anics which show that the equilibrium energy of the olecule can have only certain discrete values, not a ntinuous set. A transition between any two of these lowed levels gives rise to discrete quanta of emitted or sorbed electromagnetic energy. Since it is through its ectric or magnetic dipoles or higher poles that the olecule can interact with the electromagnetic energy of e quantum, a further condition on this quantum process is at some change in the electric or magnetic property of e molecule must occur. Most of the observed spectra are lled electric dipole spectra since a change in this mole-lar parameter is involved. The symmetry of the mole-le and of the particles which make it up leads to rules called selection rules, regarding which transitions are allowed. The spectrum of discrete quanta arising from transition between different energy levels of the molecules has been used to deduce most of our knowledge of molecular structure.

Let us assume we have a diatomic molecule, X-Y. The two nuclei are separated by a distance called r_0 (the reason for the zero will be apparent later) and the electrons form a charge cloud around them. The energy levels of the electrons are quantized and transitions between these discrete levels require an energy of the order of electron volts. Since the energy of a photon is given by

$$E = h\nu$$

where h is Planck's constant (6.6×10^{-27} ergs sec or 4.1×10^{-15} e.v. sec) and ν is the frequency, photons with an energy of electron volts have frequencies around 10^{15}/sec which are in the visible and near ultra-violet region.

Our molecule, X-Y, is still free to vibrate since the nuclei are held together by a force which acts like a spring. Again we find that the vibrational energy of the molecules is quantized and only certain stable levels are allowed. The average distance between nuclei increases in the higher states, and the value r_0 mentioned before is that for the lowest or zero order state. The vibrational levels are usually separated by about 10^{-2} electron volts and transitions between them give rise to infra-red spectra.

The end-over-end rotational motion of X-Y is also quantized and it is transitions between these rotational levels which give most of the microwave spectral lines which are observed. In order to see what knowledge can be gained from the microwave spectrum, let us look at the physical parameters which govern the frequency of the observed line. The values of the allowed energy levels, E_J, may be found by solving Schrodinger's equation in cylindrical coordinates, taking the line joining the nuclei, r_o, as the cylindrical axis. The allowed solutions are

$$E_J = \frac{h^2}{8\pi^2 I} J(J+1) \qquad (1)$$

where J is a positive integer, and I is the moment of inertia of the molecule. I is given by

$$I = \Sigma_i m_i r_i^2 \qquad (2)$$

where m_i is the mass of the i^{th} particle and r_i is its distance from the center of mass. The selection rule for this case allows transitions between states whose J differ by no more than one. This rule is usually stated as $J = \pm 1$. Therefore, the energy difference between two levels of an allowed transition is

$$\triangle E = h\nu = \frac{h^2}{8\pi^2 I} 2(J+1) \qquad (3)$$

or

$$\nu = \frac{h(J+1)}{4\pi^2 I} = 2B(J+1) \qquad (4)$$

where $B = h/8\pi^2 I$ and is called the rotational constant for the molecule. ν is the frequency of photon emitted or absorbed and J is the quantum number associated with the lower energy state. There is a small added term due to vibration, but this will be neglected here and in the following discussion.

It should be noted here that not all of the molecules are available at any one time to absorb a quantum $h\nu$. Only those in the lower state, J, can absorb this quantum. We must further note that the molecules in the J + 1 level can be made to emit a quantum under $h\nu$, the influence of a field of frequency ν. In fact, the probability that a molecule in state J + 1 will emit is the same for a molecule in state J to absorb. Therefore, only when there is a difference in population can a net absorption or emission occur. In thermal equilibrium the populace ratio of the J to (J + 1) level is given by the Boltzmann factor.

$$\frac{\text{No. in state J} \quad = N_J}{\text{No. in state J + 1} = N_{J+1}} = e^{-\frac{h\nu_{J \to J+1}}{kT}} \qquad (5)$$

where k is Boltzmann's constant and T is the temperature in degree absolute. For typical microwave frequencies, $\nu = 10^{10}$, the ratio h ν/kT = 10^{-3} so that the ratio very nearly 1. In fact only one in every 10^6 molecules excess in the lower state. This can be improved, course, by going to lower temperature, if possible. T case where (J + 1) is more populous may be called negative temperature condition and is the condition f maser action.

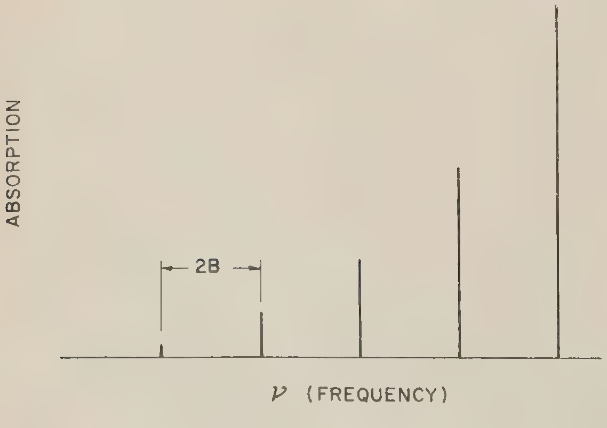

Figure 1 — Expected absorption lines of a diatomic molecule.

Figure 1 shows the expected absorption lines of a di tomic molecule as a function of frequency. They are series of evenly spaced lines, separated by an amount 2 with the absorption increasing with the cube of the fr quency.

By measuring two neighboring lines, 2B can be d termined. Since the masses of the two nuclei are known, knowledge of 2B gives an accurate measure of the equi brium distance, r_o, between them. The electron mass are neglected. It is assumed that many vibrations tal place during a single rotation so that the equilibriu distance is all that matters. There would be different r f different vibrational states. In general, however, only t lowest one is significantly populated at room temperatur

If the particular value of the rotational quantum numb J were known, only one line need be measured to d termine 2B. The value of J can often be determined l use of the Stark effect. When a molecule is subject to a external electric (Stark effect) or magnetic field (Zeema effect), then the value of its electric or magnetic m ment, which is along the direction of the angular mome tum J, can have only quantized values along the field d rection. That is to say, the vector J can have only pa ticular angles with the applied field direction. Since eac of these allowed angles represents a slightly differe energy, the energy level denoted by J is split into sublevel as many sublevels as there are allowed angles which J ma assume. Transitions then between sublevels of one J an the sublevels of J + 1, for example, give rise to a seri of lines spaced closely around the original single lin The spacing is, of course, influenced by the strength c the applied field. Since most molecules do not possess magnetic dipole moment in their ground electronic stat where most microwave measurements are made, but d posses an electric dipole moment, an electric field can b applied to split the J levels. If the electric field is larg enough, all the transitions to the different sublevels wi be resolved and may be counted to give the value of associated with the line being studied. The Stark effec also may be used to improve the sensitivity of detectio of the absorption.

The width of the observed absorption lines is, of cours finite. The most significant cause of this broadening i usually pressure broadening due to collisions with othe molecules or with the walls of the absorption cell. In th microwave range, natural line width due to the lifetime o the upper and lower state is very small. Doppler broadening due to finite molecular velocity is larger but not usuall significant. The optimum pressure for observing thes absorption lines is usually between 0.01 and 1 mm Hg.

So far we have discussed diatomic molecules. Much th same type of discussion may be used for general linea molecules, that is molecules with several nuclei along single axis. If such a molecule, OCS for example, has dipole moment it will have an equally spaced spectrum Since there are now two unknowns, r_{oc} and r_{cs}, and onl

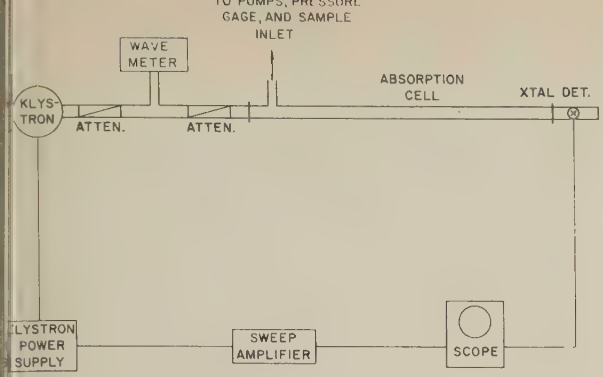

Figure 2 — Simple spectrograph.

e number found from the spectrum, 2B, additional in- mation is needed to determine the structure. This is ally obtained by substituting an isotope of different ss for one atom and measuring B again. The correction e to vibrational levels neglected before becomes more portant as more modes of vibration are allowed. A mmetric top, defined as a molecule which has equal ments of inertia along two orthogonal axes, also gives e to relatively simple spectra. Now, however, the angles ween various internuclear distances, called bond angles, er as a further unknown of the structure. Therefore, nsiderably more spectral information is required to de- mine the structure. For most molecules, however, none the three moments of inertia are equal and it is classi- d as an assymetric top. Such a molecule has a very com- x spectra from which it is often quite difficult to solve the structure. If transitions between states of low antum number can be found and identified by the rk effect, the job is greatly eased. However, many mole- les with rich microwave spectra remain to be studied.

So far the discussion has shown how some of the struc- al constants of molecules may be determined from their crowave spectra. Other parameters may also be de- rmined. For example, for the case of diatomic mole- les, if we substitute one isotope (an atom with the same mber of protons and electrons but different number of utrons, therefore a different mass) for another, the tios of the B's will give the isotopic mass ratio to great curacy. Also, if the nucleus has a spin greater than 1/2 d an associated electric quadrupole moment, this mo- ent can interact with an inhomogeneous electric field at e nucleus to perturb the rotational levels. If all the com- nents can be resolved, the value of the nuclear spin ay be determined. Also the quadrupole coupling con- ant, eqQ, which is a measure of the amount of splitting, here e is the unit charge, gives simultaneous information out the size of the nuclear quadrupole moment, Q, and the molecular parameter q which is a measure of the homogeneity of the molecular electric field. If q can calculated or if Q is known from another measurement, e second parameter is determined.

From a knowledge of the exact frequencies of high J ansitions, information about the forces which hold the olecule together is obtained. As the molecules rotate fas- i.e., J is higher, centrifugal force causes the molecules to etch apart against the binding force holding them to- ther. Since this stretching leads to a higher moment of inertia and hence a lower B, the frequencies of high J transitions will be slightly lower than one would predict on the basis of information derived from low J transitions. This discrepancy is a measure of the strength of the inter-nuclear bond.

In addition to the rotational, electric dipole spectra discussed so far, there are other important spectra which occur in the microwave region, notably the very strong inversion spectrum of ammonia, useful in atomic clocks and masers, and the magnetic dipole spectra of oxygen. The oxygen spectrum has great practical significance since it is one of the major sources of atmospheric attenuation. Diatomic, homo-nuclear gases such as N_2, O_2, Cl_2, etc. do not have any appreciable electric dipole moment and would not be expected to show microwave absorption lines. Oxygen is one of the rare molecules for which the ground electronic state is not a singlet, that is, the electron spins are not paired off. It has, therefore, a net molecular magnetic dipole moment which can and does give rise to a fairly strong microwave spectrum centered around 60 kilomegacycles with a single strong line at 125 kilomegacycles.

The equipment used for the detection of microwave spectra is simple in concept and consists of many variations on a single theme. Unlike radar or communications where one is reaching for a small needle of signal in a haystack of noise, the microwave spectroscopist is searching for a needle which is one part in 10^6 or 10^7 smaller than a whole stack of like needles. To be more explicit, a microwave "line" is found as a very small decrease in power from a large signal. The design of the spectrograph varies considerably depending on whether one is searching for unknown lines or carefully studying the detailed features of lines of known frequency.

For searching, that is, trying to find lines when you don't know exactly where they are, superheterodyne techniques have the distinct disadvantage of requiring two tracking oscillators, i.e., the probe and L.O. must sweep while maintaining a constant I.F. The simplest type of search spectrograph is shown in Figure 2. It consists of a source (usually a klystron since frequency stability is a requirement), an absorption cell with wave-guide vacuum windows and a detector. The klystron is usually electrically swept in frequency and the detector output displayed on the scope with a frequency base line. For rough searching, a cavity wavemeter is sufficient. For high resolution it is often necessary to use a frequency stabilized klystron and compare its output with a frequency standard. A good discussion of these and other techniques may be found in the texts of Gordy, Trambarulo and Smith[1] or Shawlow and Townes.[2]

The sensitivity of the simple spectrograph, described above, limits its use to molecules having an absorption coefficient greater than 10^{-6}/cm. For greater sensitivity while maintaining ease of search, a Stark effect modulation spectrograph may be used. Figure 3 shows the essentials of such a system. The modulation is usually square wave and a common modulation frequency is 100 kc. Since the noise spectrum from a crystal detector is inversely proportional to frequency, detection at 100 kc constitutes an immediate gain in sensitivity over the video detector used in the simple spectrometer above. The detected signal will be 100 kc modulated when the frequency of the

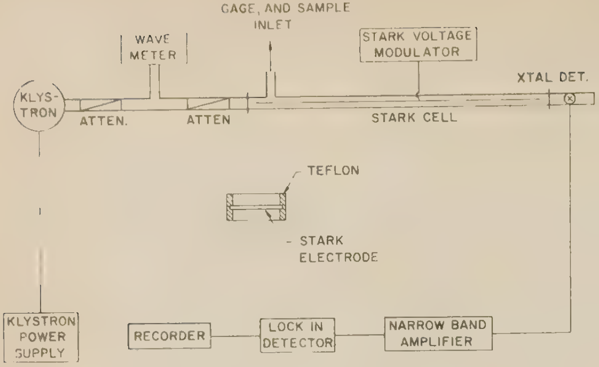

Figure 3 — Stark Modulation Spectrograph with "lock-in" detector.

source is tuned for the undisturbed line or one of the Stark components. A further increase in sensitivity is achieved if the crystal output is fed through a narrow band amplifier, tuned to 100 kc, and into a "lock-in" detector which has a reference supplied by the modulator and averages out all out-of-phase signals. The line would look like Figure 4 on a recorder, with the Stark components on the opposite side of the undisturbed line, since the undisturbed line and the Stark components will absorb at opposite phases of the square wave. This system is very sensitive, but since an effective bandwidth of cycles or fraction of cycles is often used, the rate of frequency sweep must be very slow. Thus, sensitivity is vastly improved at the expense of rate of search.

If one wishes to study a known line with very high sensitivity and resolution, then the superheterodyne technique may be used combined with a bridge to balance out the high carrier level. Other modifications of these techniques have been used, e. g., Zeeman modulation for paramagnetic gases, absorption cells at high temperatures for normally solid substances.

Most of the microwave spectroscopy done to the present has been between 3 and 60 kmc. Professor Walter Gordy's group at Duke University has extended this range above 300 kmc by using crystal multipliers. Many of the simpler molecules have been studied and their structure determined with great precision so that spectra in the m crowave region have already contributed much to ou physical understanding of molecular structure and bin ing forces. In addition, values for the spin and quadru pole moment of a number of nuclei have been determine Much remains to be learned about organic and other con plex molecules as well as free radicals or other short-live complexes. Applications of microwave spectroscopy t chemical analysis and process control appear possible bu are yet to be realized on a significant scale.

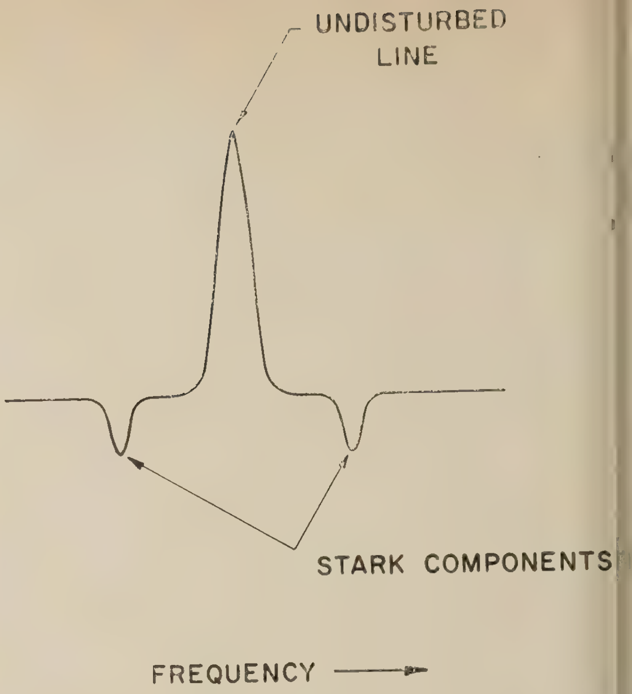

Figure 4 — Recorded line using a Stark Spectrograph and "lock-in" detector.

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A SHORT ORDER CONSTRUCTION TECHNIQUE FOR TEST ANTENNAS

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MICROWAVE PHYSICS LABORATORY
Mountain View • California

Discussion

The construction technique described herein advan-
geously uses a rapid and inaccurate mechanism to pro-
ce a highly accurate finished reflector surface. The re-
ctor configurations possible with this technique are
nfined to paraboloids of revolution, cylindrical parabo-
ds and radius-generated surfaces, e. g., toroidal para-
loids.

The reflector model package consists of a cellular box
ucture forming the light-weight support base for a
nerated plaster reflector surface. Also, a structure in-
gral with the cellular box is provided to support a ro-
ting template which generates the plaster reflector sur-
ce. This same template support structure will later serve
the reference base structure to which the antenna feed-
rn is attached. This technique then, is confined to a
ne shot" reflector device in that the generated plaster
rface and the associated structures become an integrated
it exhibiting excellent strength and rigidity for the test
ase.

Figure 1 illustrates a typical paraboloid of revolution
ructure. It is interesting to note that any plane parallel
a paraboloid axis reveals the same parabolic curve. It
therefore, an easy matter to calculate layout points for
e approximate contouring of the panel members inter-
cting the proposed paraboloid surface. The figure shows
e multi-paneled cellular box structure with an expanded
etal mesh affixed to the appropriately curved panels.
is forms an approximate paraboloid surface for the support of the wet plaster which is to be swept by the rotating template. The transverse member of the template support structure carries the upper bearing sleeve for the template shaft. The lower bearing sleeve is affixed to the base of the cellular box structure. The parabolic template

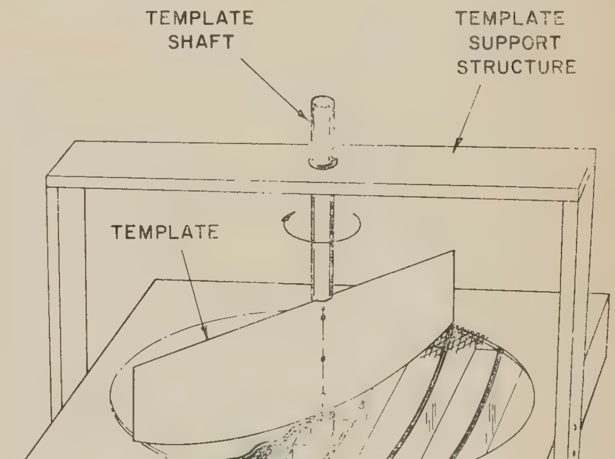

Figure 1

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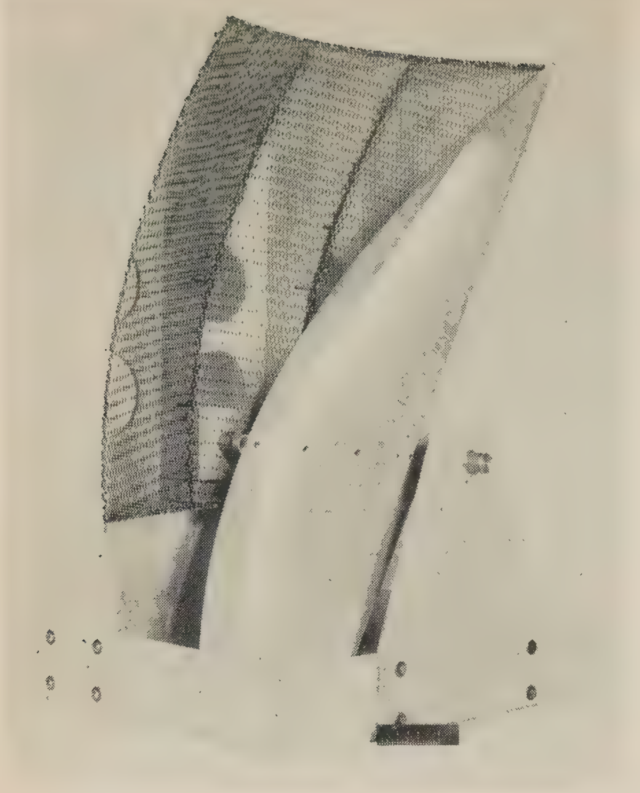

Figure 2

is mounted on a steel shaft such that the parabola's principal axis and the shaft axis are coincident. The transverse member of the template support structure should be located beyond the principal focus to facilitate the convenient mounting of the feed-horn assembly. This precaution also provides clearance between the transverse member and the top edge of the template so that the template can be raised for cleaning purposes during the ensuing plaster sweep operations.

Reflector Surface Accuracy

Obviously, the paraboloid's surface accuracy begins with the degree of accuracy held in the layout and profiling of the metal parabolic template. In the extreme case, the use of the height gauge and surface plate for layout of the coordinate points proves the most accurate. The smoothest possible curve should be scribed through these points. Careful hand filing to the scribed line produces the necessary smooth and accurate profile.

The manner in which the template is attached to the shaft is most critical. The shaft is milled out to center depth to accept the template precisely on the shaft axis. Center-lines are scribed on the milled-out surfaces of the shaft and the principal axis line scribed across the template plate. These lines are matched precisely to align template and shaft. The two parts are pinned and bolted to maintain permanent alignment.

Laboratory Model

Figures 2 to 5 illustrate the structural and process details of an offset fed paraboloid reflector. Figure 2 shows the complete and assembled structure as ready for the application and generation of the plaster paraboloid su face. The reflector surface shown is approximately inches square. It was found that 3/8 inch plywood serv well for construction of the cellular support box. T template support structure was built of 1 x 4 board a 3/8 inch plywood. The rotating parabolic template w made of 12 ga. (.080) sheet aluminum and stiffened (o side only) with aluminum angle stock appropriately spo welded into place. The stiffened template is then attach to a 1 inch diameter steel support shaft. The lower bra sleeve bearing is press-fitted into a wood block attache to the cellular box base. The upper brass sleeve bearin is press-fitted into the cantilever plywood support pane If the expanded metal mesh is of light gauge it can b hand-formed and cut so that the entire paraboloid surfa can be covered with one piece. Besides making the stru ture lighter, the numerous holes in the cellular box bas panel provide easy access for removal of excess plaste that falls through the expanded metal mesh.

Upon completion of a package design by engineering, dimensioned sketch of the cellular box structure is sub mitted to the woodshop. Rough dimensions should b included for the approximate profiling of the contoure panels. This eliminates the need of waiting for the meta template which otherwise might be used for profiling th panels. In the meantime, of course, the machine shop wi have received dimensioned sketches of all the associate hardware. Depending on the accuracy required of th paraboloid surface, the machine shop or drafting room wil receive the calculated coordinates for the layout of th template. In any event, the draftsman should join th coordinate points layed-out on the dyed sheet aluminun by using the spline and ducks technique to scribe th smoothest possible curve. Also, the parabola's principa axis should be scribed across the template to facilitat the precision mounting of the template on its suppor shaft. From the above it is obvious that all jobs can b assigned to their respective departments simultaneously.

After the cellular box structure has been nailed and glued together, a good wood sealer is applied to all surfaces. The expanded metal mesh is then affixed to the edges of the panels thus forming the approximate paraboloid surface for the wet plaster support. An aluminum expanded metal mesh is strongly recommended for its ease of trimming and compound curve forming. A heavy-duty hand stapling gun was found to be ideal for attaching the expanded metal mesh to the box structure.

The template support structure is affixed to the extended end of the cellular box perpendicular to the box base. Next, drop the template-shaft assembly into the lower sleeve bearing and install the removable upper bearing cantilever support member. Since the template rests on the lower sleeve bearing, its length establishes the height at which the template swings. The template should be positioned to clear the expanded metal mesh by approximately ½ inch. This assures adequate thickness of the generated plaster paraboloid to withstand cracking or breakage. The unit is now complete and ready for the generation of the plaster paraboloid.

The next step is the mixing of the special tooling plaster. Very low expansion plasters such as Hydrocal A-11 or Hydrocal B-11 (slow set) manufactured by the United States Gypsum Company were found to be excellent ma-

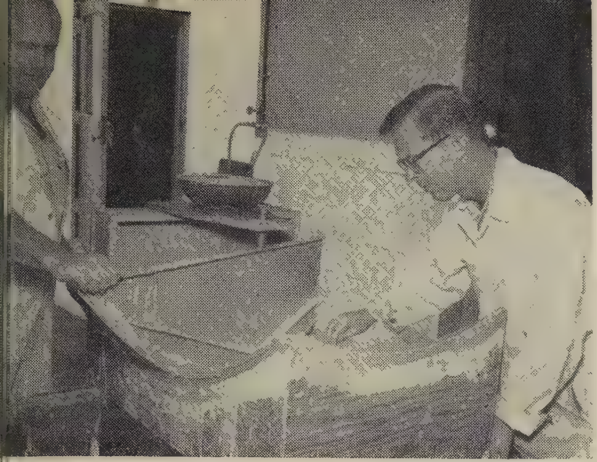

Figure 3

ls for handling, workability and strength. Mixing plaster precisely as recommended insures consistent lts and should therefore be strictly adhered to. Hydro- A-11 sets in approximately 25 minutes after mixing Hydrocal B-11 (slow set) in approximately 45 tes.

igures 3 and 4 show the plaster surface being gen- d by the rotating template. The first plaster mix is wed to set to a consistency that will not readily fall ugh the expanded metal mesh. Working quickly, the er is poured or troweled onto the mesh and the tem- e is rotated. Several mixes may be required for the gh surfacing of the entire paraboloid area. The tem- e is then lifted several inches and thoroughly cleaned h water. Next, mix a fresh batch of plaster and pour mediately. Rotating the clean template over the fresh, n mix generates the final scratch-free and accurately oth surface. As an alternative, it is possible to lift template shaft out of the lower bearing after the gh plaster surface has been generated to install a thin ring. This establishes a new template height for erating the final surface. When the final sweep opera- n has been made, lift the template off the plaster surface and lock the template-shaft assembly at the elevated attitude. After the plaster has set, carefully remove the template-shaft assembly and upper bearing support member.

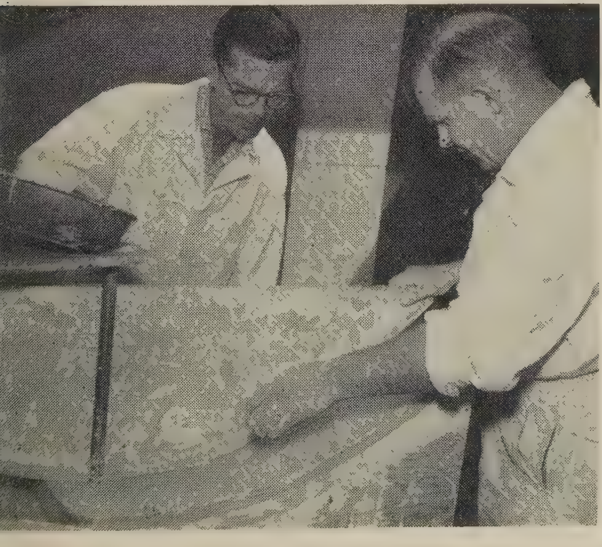

Figure 4

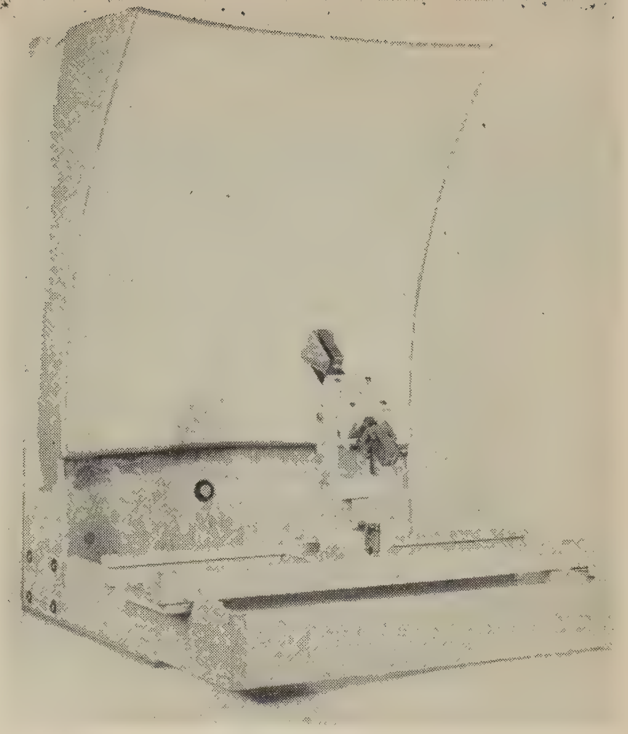

Figure 5

It was not found necessary to allow the plaster to cure before metallizing its surface. All extraneous plaster is scraped away and the paraboloid edges neatly beveled and sanded. The structure is then thoroughly masked and the paraboloid surface sprayed with a quick-dry sealer such as the wood sealer used for the cellular box. Next, the paraboloid surface is sprayed with a high-purity silver paint available from Emerson Cuming Inc. or E. I. Dupont. Although not investigated, an aluminum paint utilizing a highly evaporative vehicle should prove quite satisfactory. The metallizing operation should be repeated until a build-up of approximately .005 inches is achieved. Cementing strips of aluminum foil directly to the plaster surface has worked satisfactorily for paraboloids permitting the degree of surface irregularity inherent in this method.

Figure 5 shows a typical approach to the antenna feed-mechanism mounting. As mentioned in the discussion, what was once the template support structure now becomes an excellent reference base for the mounting of the feed horn assembly. The lower bearing now encased in the plaster paraboloid provides an excellent bore-sight device and can be plugged with a brass or aluminum disk if necessary. After a period of 12 hours for curing, the antenna package is ready for the range.

Figure 6 illustrates the structural details for the fabrication of a cylindrical parabolic reflector. For this configuration it was found more advantageous to fix the template in position and move the work piece back and forth through fixed guides. In this case, consideration must be given to the flatness and smoothness of the

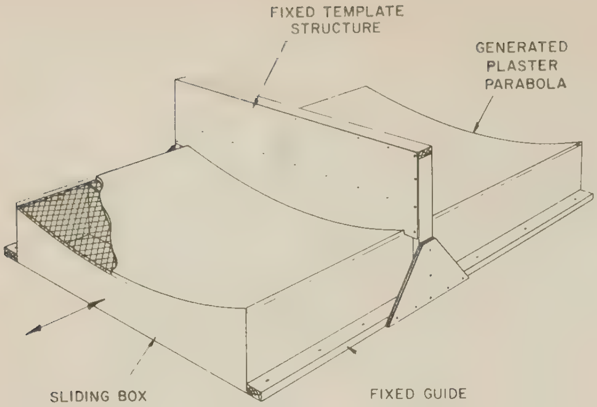

Figure 6

working surface and guides to insure smooth and vibration-free back and forth strokes under the fixed template.

For the paraboloid of revolution, or for that matter, any configuration using these techniques, it seems wise caution the designer to avoid extending the expanc metal mesh beyond the edge limits of the actual met lized surface area. The metal mesh could be "seen" elect cally if extended beyond the intended reflecting area.

Although beyond the scope and intent of this paper, t use of the tooling plaster technique for the fabrication duplicate copies of an antenna form may prove of terest. This technique employs the generation of a "ma plaster tool, again by rotary methods. After curing, mold release agent is applied to its surface. The buildir up of fibre-glass copies of the tool has proved very su cessful.

In addition, sandwich cellular structures can be ma by this technique and may even include its structural su port mechanisms.

The ideas and forms described herein are few of mar The use of the tooling plaster techniques can prove to valuable time-saving devices, thus rendering the anten and systems groups that much more effective.

NOMOGRAMS

For Microwave Filter Design

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the field of microwave filter design the most import-
parameters are: bandwidth, rejection, insertion loss,
uency, and unloaded Q which are dependent upon the
ical configuration used. Here are two nomograms
h consolidate these parameters.

nce the author's primary interest lies in high Q, i.e.,
l percentage bandwidth, bandpass devices in the mi-
ave region, this particular set of nomograms is re-
ted to filters meeting these requirements and having
terworth type of response. The method used in deriv-
them, however, can well be applied to yield similar
ograms for large percentage bandwidth filters, low-
and high-pass filters, or filters operating at other fre-
ncies in the spectrum.

initions and Basic Relationships of Parameters Used

f_o = resonant frequency of cavity resonator, also center frequency of bandpass filter in megacycles per second

f = bandwidth of filter at 3 db points in megacycles per second

$\triangle f_r$ = bandwidth of r^{th} resonator at 3 db points in megacycles per second.

df = rejection bandwidth, i.e., bandwidth of filter at some specified rejection Y in megacycles per second

Y = rejection in db

L = dissipation loss of resonator or filter in db

n = number of resonant sections in filter

r = serial number of resonator (1 through n)

${}_u$ = unloaded Q or resonator, i.e., 2π times energy stored divided by energy dissipated per cycle (dependent only upon physical constants of cavity resonator and resonant mode of operation)

${}_L$ = $f_o/\triangle f$ = overall loaded Q of filter

$Q_r = f_o/\triangle f_r$ = loaded Q of r^{th} resonator in filter (1)

Using these parameters, three basic filter design equations can be written. The frequency response characteristic of a Butterworth, i.e., maximally flat filter can be expressed by:

$$Y = 10 \log_{10}\left[1 + \left(\frac{df}{\triangle f}\right)^{2n}\right] \qquad (2)$$

The dissipation loss in the r^{th} resonator is given by:

$$L = 20 \log_{10}\left[\frac{1}{1 - Q_r/Q_u}\right] \qquad (3)$$

Finally, the loaded Q of the r^{th} resonator is:

$$Q_r = Q_L \sin\left[\frac{2r - 1}{2n}\right]\pi \qquad (4)$$

Design of a Filter using these Equations

In designing a filter to meet the following specifications let:

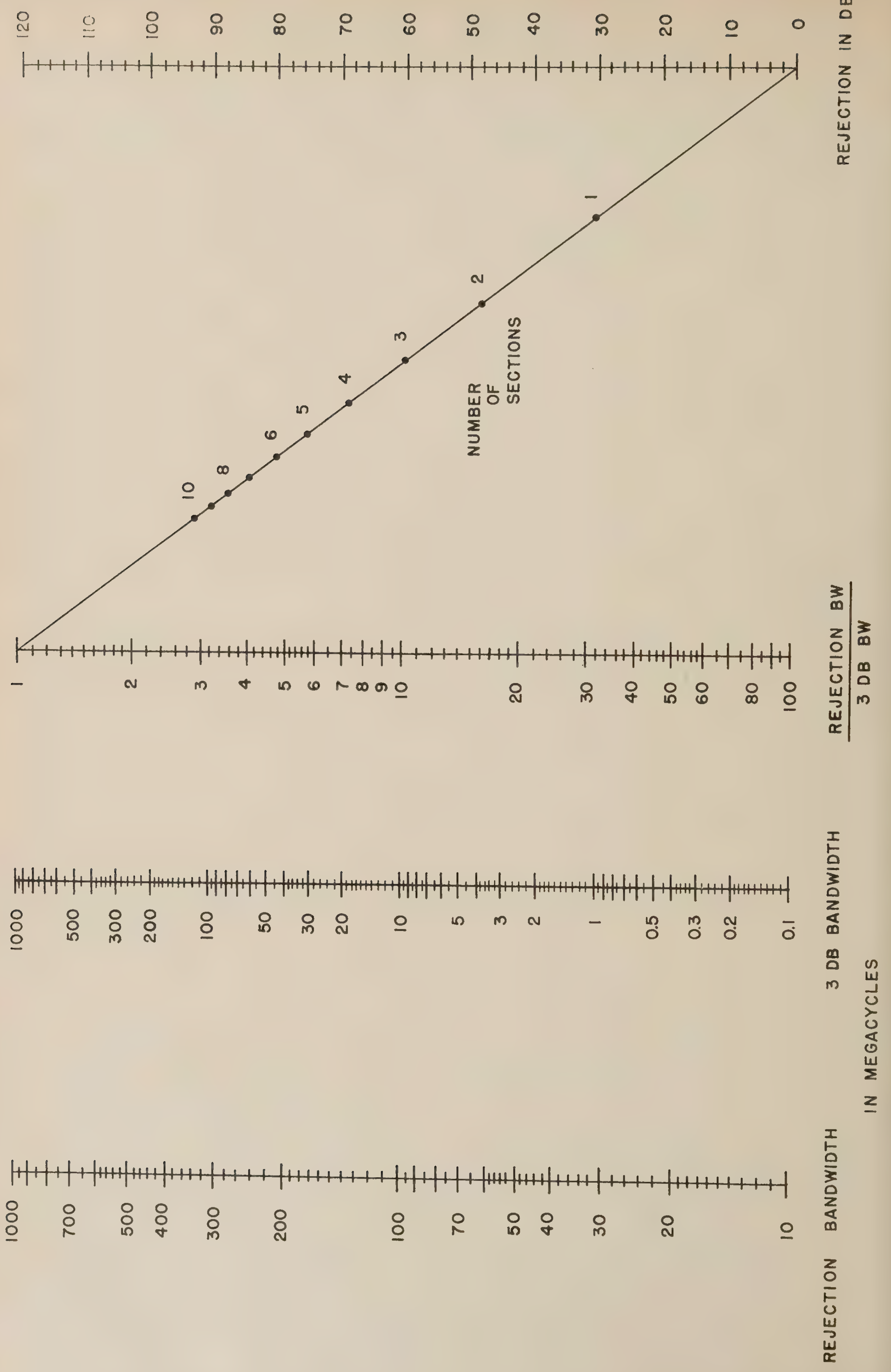
$f_o = 3200$ mcps
$\triangle f = 16$ mcps
$Y(@df = 80 \text{ mcps}) = 60$ db minimum
$L = 3$ db maximum

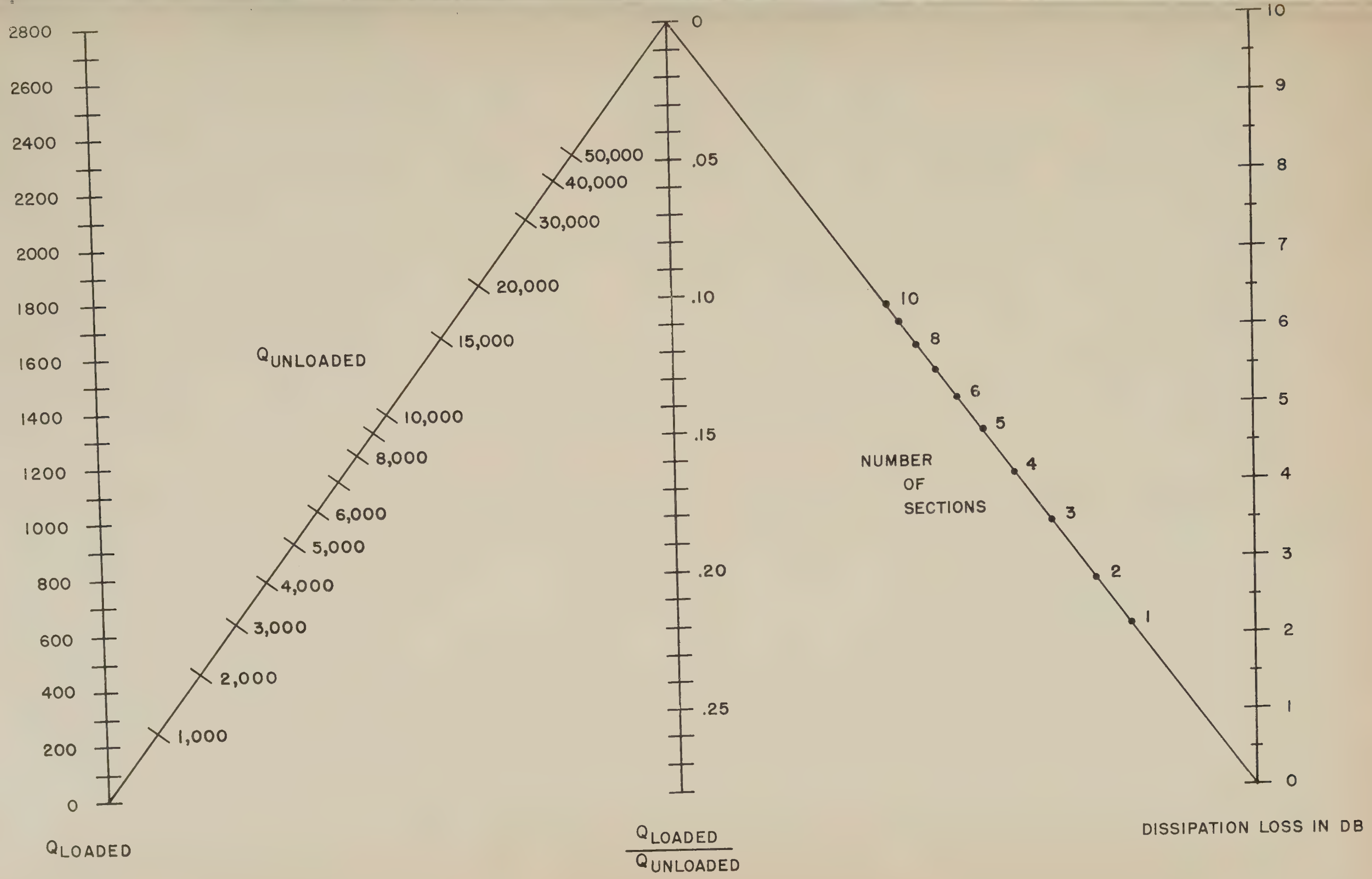
In order to specify the filter more completely and arrive at a physical design, n and Q_u must be determined for this filter.

Solving equation (2) for n:

$$60 = 10 \log_{10}\left[1 + \left(\frac{80}{16}\right)^{2n}\right]$$
$$n = 4.3$$

In practice, an integral number of resonators must be used, therefore, the n necessary to supply the rejection as specified must equal 5.


REJECTION BANDWIDTH
1000
700
500
400
300
200
100
70
50
40
30
20
10
3 DB BANDWIDTH
IN MEGACYCLES
1000
500
300
200
100
50
30
20
10
5
3
2
1
0.5
0.3
0.2
0.1
REJECTION BW
3 DB BW
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
80
100
NUMBER OF SECTIONS
1
2
3
4
5
6
8
10
REJECTION IN DB
120
110
100
90
80
70
60
50
40
30
20
10
0


2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Q LOADED
Q UNLOADED
1,000
2,000
3,000
4,000
5,000
6,000
8,000
10,000
15,000
20,000
30,000
40,000
50,000
0
.05
.10
.15
.20
.25
Q LOADED / Q UNLOADED
NUMBER OF SECTIONS
10
8
6
5
4
3
2
1
10
9
8
7
6
5
4
3
2
1
0
DISSIPATION LOSS IN DB

In order to find what minimum value of Q_u the resonators must have in order not to yield in excess of 3 db loss for the entire filter, the sum of the losses of the individual sections must not exceed this value. The loaded Q of the filter and those of its individual resonators are now computed:

$$Q_L = f_0/\triangle f = 3200/16 = 200 \qquad (1a)$$

solving (4) for Q_1 through Q_5:

$$Q_1 = Q_5 = 0.309\ Q_L = 61.8 \qquad (4a)$$

$$Q_2 = Q_4 = 0.810\ Q_L = 162 \qquad (4b)$$

$$Q_3 = Q_L = 200 \qquad (4c)$$

The overall loss of the filter is therefore given by summing the results of equation (3) for the individual sections as shown below:

$$L = 40\ \log_{10}\left[\frac{1}{1-\left(\frac{61.8}{Q_u}\right)}\right] + 40\ \log_{10}\left[\frac{1}{1-\left(\frac{162}{Q_u}\right)}\right] + 20\ \log_{10}\left[\frac{1}{1-\left(\frac{200}{Q_u}\right)}\right] \qquad (3$$

By choosing various values of Q_u and solving for the loss, it is found that the loss for an unloaded Q of 2000 is 2.93 db, which is close enough to show that Q_u must have a minimum value of 2000 if the above specifications are to be met.

The filter has now been completely specified and a practical design may be achieved using the information above, the correct coupling parameters, and some microwave techniques.

Approximations and Design of Nomograms

Examination of equation (3) shows that loss increases with increasing Q_r/Q_u. Futher examination also shows that up to a relatively small value of Q_r/Q_u the loss varies nearly linearly with this ratio. The value here chosen is slightly less than $Q_r/Q_u = 0.3$ which corresponds to approximately 3 db loss for a single resonator. Due to practical considerations discussed later, it appears safe to assume this linear relationship up to the value stated. This approximation in itself would greatly simplify the computations shown above, but a relationship of this nature also provides the basis for a nomogram. From the trigonometric function of equation (4), average values of Q_r may be found for any number of sections, which in computation, may be assumed to be the Q_r's of all the sections of a filter. These average values need only to be evaluated for loss and these losses multiplied by their respective number of sections to give the overall loss of a filter. The dissipation loss nomogram does just this since it basically consists of a plot of the three variables: Q_r/Q_u, L, and n, with the single exception that the ratio axis scale has been adjusted to read Q_L/Q_u directly instead of Q_r/Q_u. In order to make its use more practical, the nomogram also contains the variables Q_L and Q_u plotted on individual axes so that any three of the four variables: Q_L, Q_u, L and n will yield the fourth by simply drawing two straight lines between appropriate points.

The rejection nomogram is designed in a similar fashion, with the exception that no approximations were necessary in its design. It, too, will yield the unknown variable when any combination of three of the four variables: df, $\triangle$f, Y, and n are given.

Use of Nomograms and Comparison of Results

The preceding information is almost sufficient for telligent use of these nomograms. It is of interest, ho ever, to solve the previous example by means of the nom grams, so that the results may be compared. It is called that the first problem was to find the number sections necessary for adequate rejection. On the rejecti nomogram a straight line is drawn through a rejecti bandwidth of 80 mcps and a 3 db bandwidth of 16 mc to get the rejection ratio, in this case 5.0 (This step m appear superfluous, but it must be remembered that filt requirements do not usually contain such simple nume cal relationships.) From the point thus found anoth straight line is drawn to 60 db on the rejection sca This line is found to cross the n scale at a point betwe 4 and 5, thus indicating that five sections must be us for this particular filter. In order to find the require unloaded Q, the loss nomogram is used. Again a straig line is drawn, this time through the 3.0 on the loss ax and the 5 on the n scale giving approximately 0.097 the Q-ratio scale. From this point a straight line is draw to a loaded Q of 200, and it is found that this line inte sects the unloaded Q scale just above 2000.

The sample problem has been solved, and good agre ment is shown between those results and those obtaine using the lengthy exact solution. The author has compare results of numerous examples and feels confident th practically all possible filter designs which can be plotte on the scales of the nomograms will yield equally goo results.

Practical Considerations

In the actual design of microwave filters several factor which would further point toward reliability of thes nomograms are usually taken into account. First, since th unloaded Q of a cavity resonator depends upon the physical constants of the cavity, practical values often differ considerably from the theoretical ones, due to variations i silver plating, fabrication, etc. Therefore, some factor o safety is usually incorporated in the computation for unloaded Q of a resonator. Another safety factor is use in the computation of rejection because effects of direc coupling and small variations in the coupling parameter will produce less than theoretical rejection in a practica filter.

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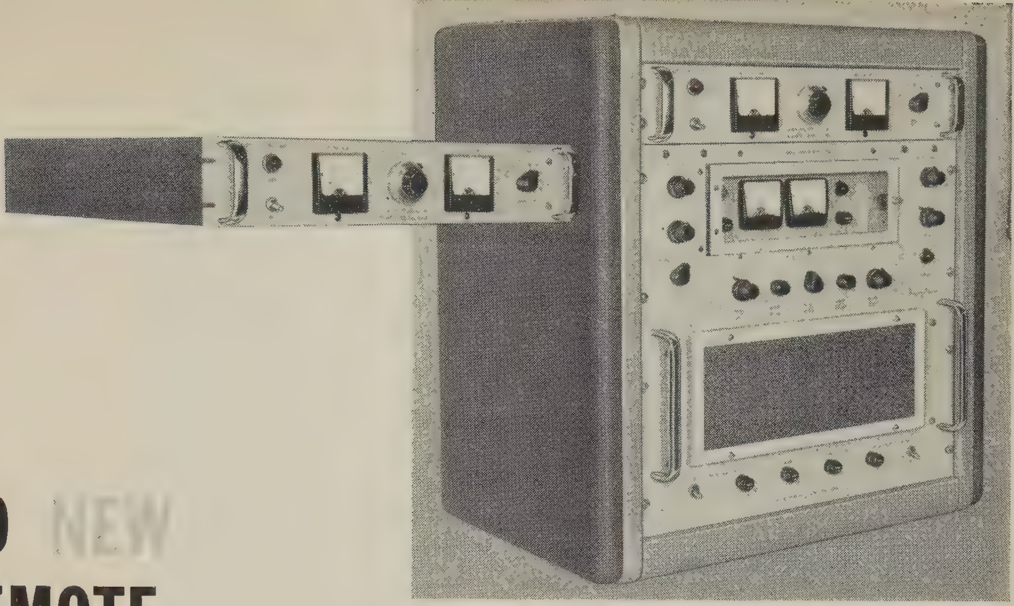

Model SS 20 Signal Source Power Supply with Tuning Unit. Tuning Unit is removed to control position for remote operation. Inset shows unit removed for remote operation. In this mode, control unit can be operated up to one mile away.

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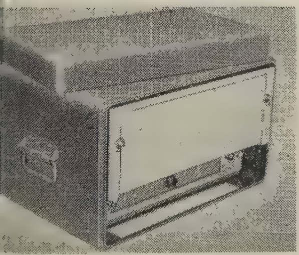
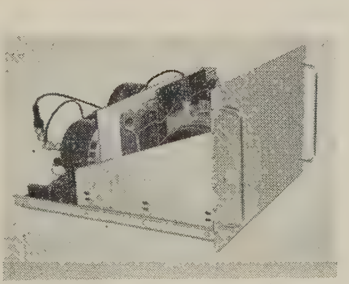
Tuning Chart Accuracy	±2%	±5%
Frequency Resettability	±0.5%	±0.1% or 5 mc, whichever is greater
Power Output	80 mw into 50-ohm load	see table of RFO Oscillators



therproof Enclosure and a Series Oscillator Unit.



Model SS 30 RF Oscillator Unit

SERIES RFO OSCILLATOR UNITS

MODEL	FREQUENCY RANGE	OUTPUT POWER
RFO 1	1.0 - 2.0 kmc	40 - 800 mw
RFO 2	2.0 - 4.0 kmc	100 - 800 mw
RFO 3.6	3.6 - 7.2 kmc	5 - 300 mw
RFO 7	7.0 - 11 kmc	20 - 300 mw
RFO 8.5	8.5 - 16 kmc	5 - 100 mw
RFO 15.5	15.5 - 24 kmc	5 - 125 mw
RFO 23.5	23.5 - 37.5 kmc	5 - 100 mw

PRICES

Model SS 30, $3,850; SS 20, $3,550; SSG 1 Sine-Square Wave Generator, $350; RFO 1, 2 and 3.6, $1,400; RFO 7, $1,900; RFO 8.5, $2,060; RFO 16, $3,330; RFO 23.5, $3,330. For more details, please contact your S-A representative or write directly. Address Dept. 69

e Us At WESCON Booths 538-539

SCIENTIFIC-ATLANTA, INC.

2162 PIEDMONT ROAD, N. E. • ATLANTA 9, GEORGIA 5

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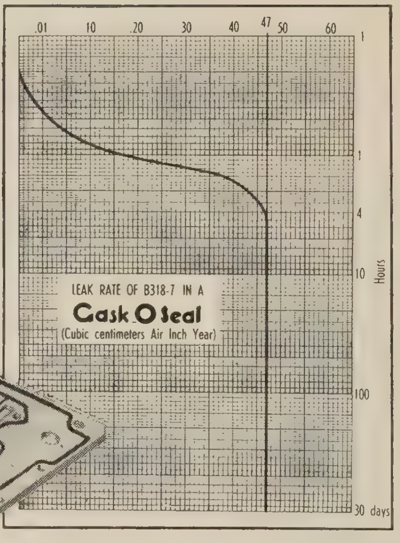
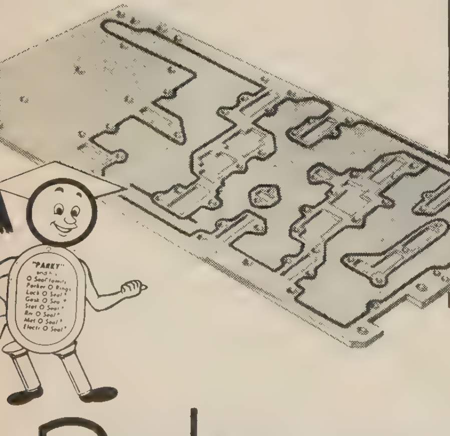
Gask-O-Seals meet, or exceed grade A MIL-8484 specifications for hermetic sealing, yet they are mechanical. That means you can seal a vacuum and still achieve full serviceability — easy access for repair, maintenance, re-setting, etc. You can seal components, "black-boxes," instruments, even complete systems — and re-seal them with the *same* seal!

The seal shown below illustrates the versatility of Gask-O-Seal — one piece seal actually doing the job of ten! Think of the freedom of design such a seal offers. Can they be put to use for your products, too?

The chart at right is an actual reproduction of a test which reveals a leak rate of less than 1 cc/air/inch/year—exceeding top hermetic requirements.

For more information about Gask-O-Seals send for catalog 5800.





Parker SEAL COMPANY
Culver City, California and Cleveland, Ohio
A DIVISION OF PARKER-HANNIFIN CORPORATION

ker also makes Seals for Wave Guide Flanges that prevent R/F leakage and provide a itive no-leakage seal; a self sealing flush-head rivet called Riv-O-Seal, and many r specialized seals as well as O-Rings and Back-up Rings. Your inquiry is invited.

Industry News

(*Continued from page 22*)

FXR NAMES TORE N. ANDERSO EXECUTIVE VICE PRESIDENT

Election of Tore N. Anderson as ecutive vice president and general m ager of FXR, Inc., Woodside, N. manufacturer of microwave and ot electronic equipment, has been announ by Henry Feldmann, president.

Mr. Anderson joined the company assistant to the president earlier t year after 12 years with Airtron, Inc. division of Litton Industries. He w named Airtron's chief engineer in 19 a director and vice president in 19 and director of engineering in 1956.

He has been chairman of the Wa guide Connector Standardization S committee of the Electronics Indus Association since 1954; participated cently in the ULM, Germany, meetings preparation of an international standa for waveguides and wavequide conn tors, and since 1959, a consultant to t Defense Department's Advisory Gro of Electron Parts, Working Group Transmission Lines.

A senior member of the Institute Radio Engineers, he was chairman of t Northern New Jersey Section and ganized the chapter's Professional Gro of Microwave Theory and Techniqu He is now a member of the administ tive committee and vice chairman of t Group. He also is a member of t American Physical Society and the Am ican Institute of Electrical Engineerin and a member of the Tau Beta Pi a Mu Alpha Omicron Honor Societies. received his BS Degree from Coop Union.

Mr. Anderson is also an editor of t *microwave journal.*

—mwj—

NARDA APPOINTS NEW SALES MANAGER

Edward S. Hensperger has been a pointed Sales Manager of the Narda M crowave Corporation, Mineola, Long I land, N.Y., according to an announc ment by Mr. William A. Bourke, Pre dent. Mr. Hensperger's appointment effective August 1, 1960, when he wi assume full responsibility for the enti marketing program for Narda Micr wave.

Mr. Hensperger comes to Narda fro Waveline, Inc., New Jersey manufa turer of microwave test equipmen where he held the position of chief e gineer. His other experience includ positions as section engineer in char of the advanced microwave design grou at Airtron, Inc., and as senior desig engineer at Stavid Engineering.

Mr. Hensperger is a native of Ne Brunswick, N.J. He served three and half years in the Marine Corps in th South and Central Pacific theaters durin World War II, after which he entere Rutgers University in 1948. He receive the degree of BS in electrical enginee ing in 1952.

◆ **Circle Reader Service Card 33**

We hate stereotypes, eric statements and even veiled illu- ns. Therefore, we cannot say that *all* ineers love sports cars. We can say, vever, (with some degree of safety) t some do. As a matter of fact, we have e at Rantec that's a nut, with wire eels and knock off hubs yet. Much has n claimed for this seeming predilection the part of the engineer. That there is a inite comparison with his own profes- nal art and the whine of an engine at 00 rpm is, to us, a rather weak argu- nt. This engineer and/or nut is a asant enough fellow, quiet, talented the extreme, we might add), and a ily man with a large second mortgage. first glance, his demeanor is in, well, Pontiac class. But if one is possessed a little insight, one sees deep within s gentleman's eyes a romance — cor- ting at 65 mph, Weber carbs and over- d cams.

Although like this man and respect him, we think of this is a trifle sad. The modern sports is truly fine technical machinery, but popularity in Southern California and stport, Connecticut, makes them pect. A love affair between an engineer a Stutz Bearcat, Mercer Raceabout th T-head) or a Hispano-Suiza Bou- ne we could understand. These cars re great not because of their purities ne gentleman installed a cigarette hter in his Porsche Super 90 and was ummed out of the Altoona Sports Car ub), but, essentially, because of their purities. Take the Auburn 13 Boat-Tail, r instance. Now there was a car. Twelve linders in line, six miles to the gallon d a lacquered planked wood body that re a greater resemblance to Columbus' nta Maria than anything automotive. t, at the mere mention of a Deusenberg , our engineer grits his teeth and says, an it go from zero to 60 and back to ll stop in 20 seconds" We are puzzled. his so-called advantage might be quite od for kangarooing about in downtown affic or for burping the baby, but for ing down to the grocery store for a can salmon it seems to leave a little some- ing lacking.

Despite it all, we are big- earted, even though this engineer umbles disrespectfully every time we ss him in the lunchroom, "Detroit on!". And with such vehemence. We tell u, if it weren't for the fact that he's one the smartest guys around, we'd . . . Any gineer with experience in ferrite devices, aveguide components, rf-telemetry evices, microwave subsystems and e Sotos, please call Rantec, Calabasas, alifornia. No Volkswagens, please. hey're the worst.

MERCURY
TITAN
POLARIS
DISCOVERER
MIDAS
NIKE ZEUS
NIKE HERCULES
SUBROC
SAMOS
X-17

Since 1956 missile and satellite programs have depended for their success, in part, on **Rantec multiplexers and filters for telemetry**... unique devices which couple two, three, four or six telemetry signals to a single antenna system. A wide variety of tunable models covers the entire telemetry band. Typical specifications on recent models include **Isolation between channels to 100 db with 0.5 db insertion loss VSWR — 1.3 Maximum.** Rantec multiplexers, *hermetically sealed and helium leak-tested for storage and long-time space use,* are another example of Rantec's proven capability in ground and airborne telemetry devices.

Rantec Corporation Calabasas, California

r a n t e c

also from Rantec . . . antennas, ferrite devices, waveguide components, electronic components and microwave sub-systems.

See Rantec at WESCON Booth #2207

Circle Reader Service Card 34

SPERRY *Microline*® NEWLY DESIGNED IN 1960

Sperry has created new designs for its entire line of Microwave Instruments to make this the most complete and up-to-date inventory in the industry.

WAVEGUIDE INSTRUMENTS

FREQUENCY BAND CODE LETTER	S	C	G	H	X	U	K	V
INSTRUMENT	3x1½ 2.6-3.95 KMC	2x1 3.95-5.85 KMC	1½x¾ 5.85-8.2• KMC	1¼x⅝ 7.05-10.0 KMC	1x½ 8.2-12.4 KMC	.702x.391 12.4-18.0 KMC	.500x.250 18.0-26.5 KMC	.360x.22 26.5-40. KMC
Frequency Meter, Direct Reading	12S1 **$450**	12C1 **$250**			12X1 **$150**	12U1 **$210**	12K1 **$230**	
Frequency Meter, Precision	14S1 **$850**	14C1 **$565**	14G1 **$450**		14X1 **$450**			
Waveguide Slotted Line†	**21S1 **$450**	*21C1 **$110**			*21X1 **$90**	*21U1 **$110**		
Universal Carriage		21A1 **$160**			21A1 **$160**	21A1 **$160**		
Adjustable Shorts	23S1 **$100**	23C1 **$70**	23G1 **$60**	23H1 **$50**	23X1 **$40**	23U1 **$90**	23K1 **$130**	23V1 **$1**
Reflectometer Coupler	24S1 **$600**	24C1 **$350**			24X1 **$175**			
Barretter Mount, Fixed	33S2 **$150**	33C2 **$140**	33G2 **$130**		33X2 **$70**			
Tunable Detector Mount	34S1 **$180**	34C1 **$95**	34G1 **$90**	34H1 **$85**	34X1 **$75**	34U1 **$160**	34K1 **$170**	34V1 **$1**
Termination, Low Power	42S1 **$50**	42C1 **$40**	42G1 **$35**	42H1 **$30**	42X1 **$25**	42U1 **$30**	42K1 **$30**	42V1 **$**
Termination, High Power	43S1 **$150**	43C1 **$140**		43H1 **$100**	43X1 **$85**			
Crossguide Coupler, 20 to 50 db	44S2 **$150**	44C2 **$130**	44G2 **$90**	44H2 **$80**	44X2 **$60**	44U2 **$80**	44K2 **$100**	44V2 **$1**
Level Set Attenuator					47X1 **$45**	47U1 **$50**		
Adapter	54S1 **$70**	54C1 **$40**			54X1 **$35**		54K2 **$25**	54V2 **$**
Standard Gain Horns	56S1 **$175**	56C1 **$150**	56G1 **$125**	56H1 **$120**	56X1 **$90**	56U1 **$110**	56K1 **$110**	56V1 **$1**

* Mounts in 21A1 Universal Carriage

** Complete Assembly includes carriage

† 21L1 Slotted line in 6.660″x3.410″ Waveguide also available—complete assembly including carriage.

• Certain Instruments cover range 5.2-8.2 KMC.

ELECTRONIC INSTRUMENTS

INSTRUMENT	APPLICATION	FREQUENCY RANGE	FEATURES	PRIC
Model 29A1 Standing Wave Indicator	SWR Indicator Null Detector, TAA	300-5000 Cycles	Adjustable Bandwidth Bolo Current Readout	**$20**
Model 29A2 Input Switch	Used with 29A1 SWR Indicator	—	Convenient for Comparison Measurement	**$3**
Model 31A1 Average Power Meter	R-F Power Measurement	Per Bolometer Mount	± 3% Accuracy, .02 to 10 MW	**$24**
Model 31A2 Peak Power Meter	R-F Peak Power Measurement	Per Bolometer Mount	± 10% Accuracy, Direct Reading	**$120**
Model 62A1 Universal Klystron Power Supply	Universal Power Source for Klystrons	—	200-4000 Beam Volts @ 150 MA .01% Regulation 0-1000 Reflector Volts 3 MV Max. Ripple	**$130**
Model 62A2 D. C. Klystron Filament Supply	D. C. Filaments for high stability operation	—	Adjustable Output Voltage Low Ripple	**$19**

COAXIAL INSTRUMENTS

INSTRUMENT	APPLICATION	FREQUENCY RANGE	FEATURES	PRICE
Model 72L2, 72S2, 72C2, 72H2 Isolators, Low Power	Source Component Isolators for Laboratory Measurement	1-2 2-4 4-7 7-11 KMC	High Isolation Low VSWR	**$25** **($180 for H-Band**
Model 12L1 Broadband Frequency Meter	Frequency Measurement	660 to 3000 MC	Transmission type measurements including meter with sensitivity control Direct Reading	**$55**
Model 21B1 Tunable Broadband Probe	Detector for Slotted Line Measurements	1-18 KMC	Ultimate in Tuning Ease	**$12**
Model 33B2 Coaxial Thermistor Mount	R-F Power Measurements	10 MC to 10 KMC	Fixed Tuned, Low VSWR	**$7**
Model 34B1 Tunable Coaxial Detector Mount	R-F Detector	1.0 to 12.4 KMC	Convenient Broadband Operation	**$12**
Model 54B1, 54B2, 54B3, and 54B4 Coaxial Adapters	Transition from ⅞ to ⅜ Coax. ⅞ to ⅞ Coax.	0 to 10 KMC	Low VSWR	**$4**

(See the new equipment at the WESCON SHOW, Booths 2148-9)

SPERRY
50 YEARS 1910 1960

SPERRY MICROWAVE ELECTRONICS COMPANY, *CLEARWATER, FLORIDA • DIVISION OF SPERRY RAND CORPORATIO*

Circle Reader Service Card 35

. . . also from the

SPERRY MICROWAVE ELECTRONICS COMPANY

ERRITE ISOLATORS

complete line of ferrite isolators, circulators, and other solid state devices—or research and production—from the industry's foremost ferrite and solid state boratory.

TYPICAL SOLID STATE ISOLATORS AND CIRCULATORS

	To 500 mc J	.5-1 kmc P	1-2.6 kmc L	2.6-3.95 kmc S	3.95-5.85 kmc C	8.2-12.4 kmc X
gh Power Coaxial Isolators	D44J6	D44P6	D44L6	D44S2		
gh Power Waveguide Isolators			D41L1	D41S1	D41C1	D41X1
gh Power Ridge Waveguide				D42S2	D42C2	D42X2
gh Power Duplexers	D51J1	D51P1	D51L1	D51S1	D51C1	D51X1
oadband Laboratory Isolators			72L2	72S2	72C2	72X2
iniaturized Isolators			D44L7	D44S7	D44C7	
iniaturized Tee Circulators	D52J1	D52P1	D52L1	D52S1	D52C1	

ICROWAVE ANTENNAS, SUBSYSTEMS, AND COMPONENTS

perry has been developing and producing microwave antennas, subsystems, and omponents for numerous radars and other such equipments covering the entire icrowave spectrum.

EST SETS AND SYSTEMS INSTRUMENTATION

rom small portable field test equipment to large complex automatic checkout quipment, Sperry has pioneered in combination test sets, performance monitors nd evaluators, RACE™, and simulators.

ombination Test Sets

odel 670	—	400-450 mc
odel 590	UPM-44C	2.7-3.5 kmc
odel 552	SPM-5	5.4-5.9 kmc
odel 570	UPM-32	8.5-10.5 kmc
odel 557	UPM-42	23.5-24.5 kmc
odel 580A	UPM-14	34.0-35.6 kmc

ange Calibrators

-	UPM-11	8.5-9.6 kmc
odel 551A	SPM-6	5.4-5.9 kmc
odel 619	—	15.7-17.0 kmc
odel 610	UPM-40	23.5-24.5 kmc

FM Test Sets

Model 38A	TS-147B	8.5-9.6 kmc
Model 729	UPM-29A	15.7-17.0 kmc

VSWR Test Sets

Model 539A	UPM-12A	8.5-9.6 kmc
Model 727	UPM-27A	15.7-17.0 kmc

Spectrum Analyzer

Model 728	UPM-28A	15.7-17.0 kmc

Radar Performance Monitors In X- and C-Bands

(See the new equipment at the WESCON SHOW, Booths 2148-9)

SPERRY 50 YEARS 1910-1960

ERRY MICROWAVE ELECTRONICS COMPANY, *CLEARWATER, FLORIDA · DIVISION OF SPERRY RAND CORPORATION*

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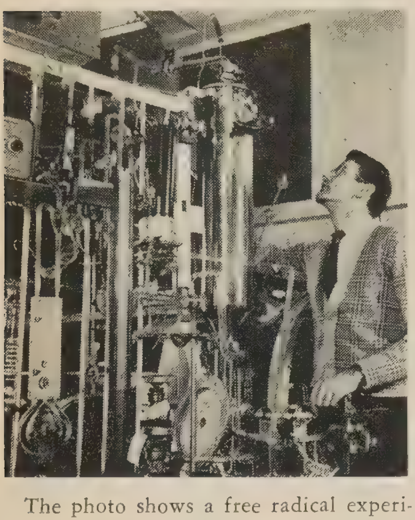
New Products

INVISIBLE SPECTRA DEWARS FOR FREE RADICAL RESEARCH



The photo shows a free radical experiment, utilizing spectra of invisible ultraviolet rays. In free radical studies such as this, scientists have been able to produce atomic nitrogen, oxygen and hydrogen, as well as some of the simpler hydrocarbon radicals. It may eventually become possible to make entirely new chemical compounds with unique characteristics, or to find more commercially feasible methods of producing such familiar substances as ozone, hydrogen peroxide, etc., through the control of free radicals.

The liquid helium research dewar at the center of the photo is the product of Hofman Laboratories, Inc., Hillside, N.J., designers and producers of liquid helium research dewars for microwave spectrometry, superconductivity studies, low temperature chemistry, nuclear research, etc. A 44 page catalog with engineering data is available.

Circle Reader Service Card 101

— m w j —

NEW PACKAGING METHOD PRODUCES MESA TRANSISTORS AT GROWN-JUNCTION COSTS

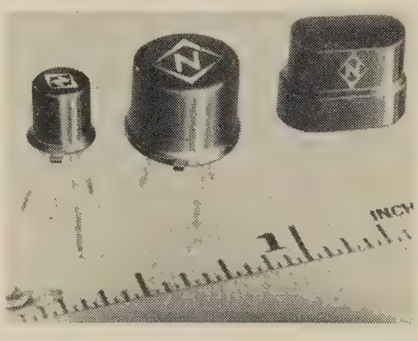
A new method of packaging the same basic transistor in several package sizes lets National Semiconductor Corp., Danbury, Conn., produce mesa transistors at the cost of grown-junction devices.

Mesa construction results in improved high frequency performance and other desirable characteristics. Fabricating one series of transistors for all packages permits larger volume and lower unit costs.

The new method, first applied to 2N332A and 2N337 series small-signal NPN silicon transistors, was announced by John F. Hegarty, vice president — marketing of National Semiconductor. He explained that the basic transistor, in a TO-18 hermetically sealed welded can, is encapsulated with epoxy resin to build up the package size to TO-5 and other EIA and military configurations.

Epoxy encapsulation forms an additional hermetic seal, increasing environmental protection. The epoxy build-up also makes the transistor's leads less likely to break when bent during assembly operations.

Alpha cutoff frequency is 100 mc against 8 to 20 for comparable grown-junction transistors. Emitter-base breakdown potential is 6 v, compared with 1 v; leakage current 0.2 microamp, against 1.0 output capacitance 6 micro-microfarads, against 30; collector saturation resistance 50 ohms, against 100.

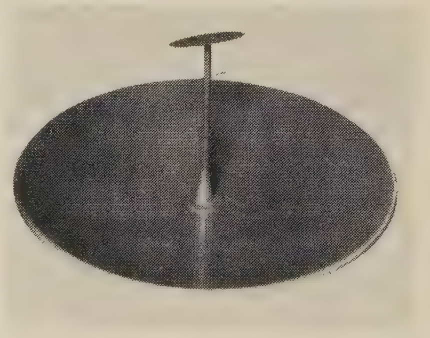


TO-18 packaged transistors include types 2N756, 2N757, 2N758, 2N759, 2N760, 2N761 and 2N762. Electrical counterparts in TO-5 packages are 2N332, 2N332A, 2N333, 2N333A, 2N334, 2N334A, 2N336, 2N336A, 2N337 and 2N338 types. Oval packages include types 2N1149 through 2N1156 and 2N243 and 2N244.

Circle Reader Service Card 102

— m w j —

NEW TRANSMITTING ANTENNAS



A new series of transmitting antennas — each featuring wide frequency coverage — has been designed by Scientific-Atlanta, Inc., Atlanta, Ga., for outdoor service on microwave antenna test ranges.

The company's Series TA transmitting antennas give maximum frequency coverage for each reflector with a minimum number of interchangeable feeds. They are rugged instrumentation antennas, comprised of combinations of S-A's Series TAR and TAF Transmitting Antenna Reflectors and Feeds.

The new antennas feature high gai optimum side lobe — bandwidth cha acteristics, optimum impedance — band width characteristics and easily inte changeable feeds.

Reflectors are rugged spun aluminu paraboloids which range in diamete from one foot to 10 feet. Each reflecto assembly includes a feed mount wit quick feed interchange capability fo supporting any one of a family of feed at the focal point of the reflector.

Circle Reader Service Card 103

— m w j —

RADAR POWER BOOSTER SHARPENS MISSILE DETECTION

Sperry Gyroscope Co., Great Neck, N.Y., has released the first photo that reveals details of a new microwave tube, a multi-megawatt amplifier that boosts output power of military radars 5000 times, for more precise tracking of missiles at longer ranges than formerly possible. The tube's short wavelength, half as long as in earlier super-power tracking systems, provides sharper beams for pinpointing small missiles.

Mid-section of tube employs 100 ampere electron beam to generate 3,000,000 watts of radar power which can "see" missiles at longer ranges. Pointed white cone (upper left) is a "window" made of a ceramic similar to sapphire which is transparent to microwave power. It passes the tube's intense output power to the radar's antenna while sealing output pipe against the tube's ultra high vacuum, a pressure one trillionth that of normal room atmosphere. The tube was developed by Sperry Gyroscope Company for use in several kinds of missile radars.

Circle Reader Service Card 104

(*Continued on page* 70)

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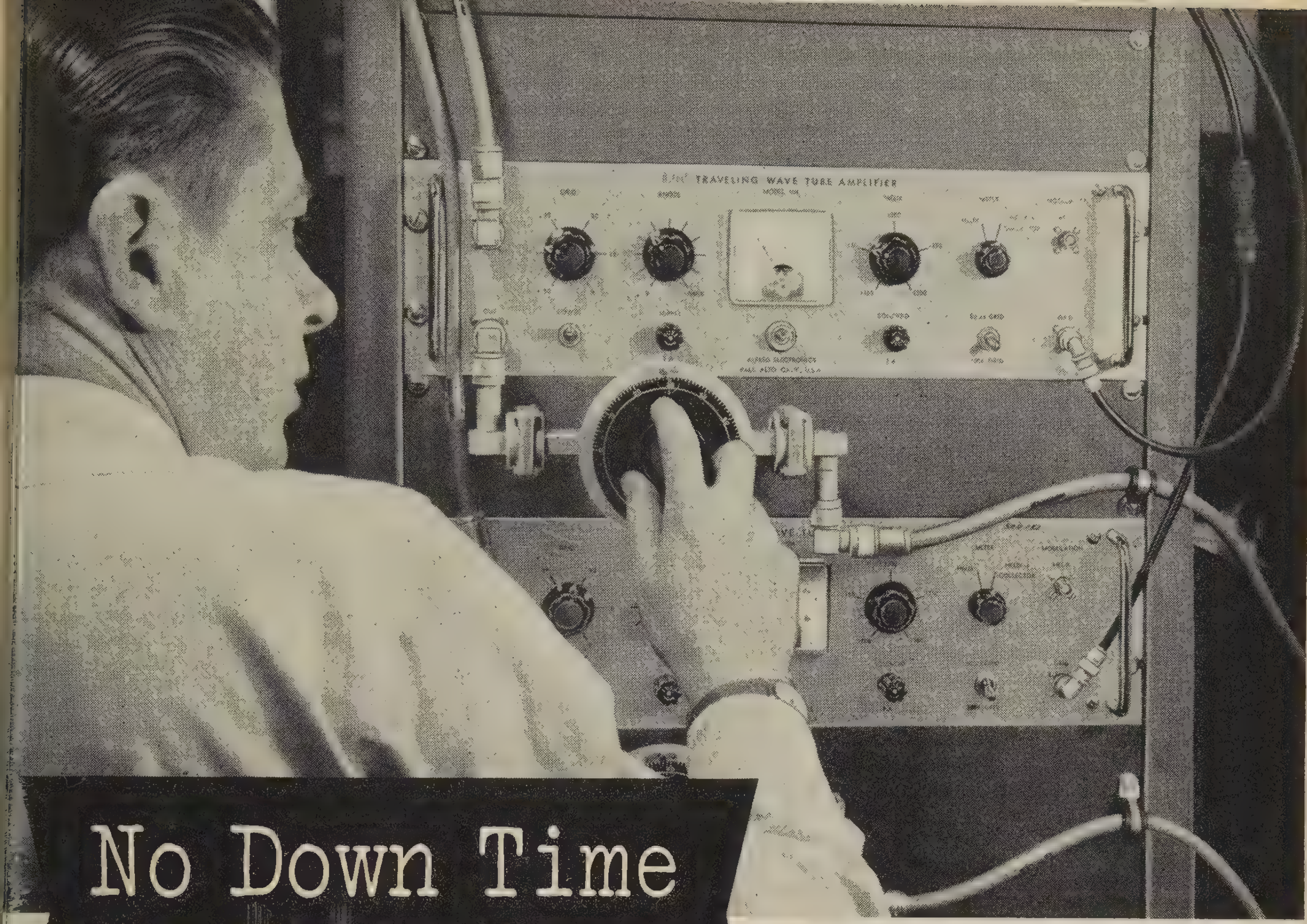


No Down Time Is Normal . . .

Alfred Electronics Model 504 Microwave Amplifiers, in use at Hughes Aircraft Co., Culver City, California

with ALFRED Microwave Amplifiers

These Alfred TWT microwave amplifiers have seen continuous service at Hughes for over 9 months. There has been practically no down time even for replacement of TWT tubes. Used in the RF portion of a missile testing system, the Alfred units provide high gain, wide band, flat response and low spurious modulation from 8 to 12.4 kmc. Hughes engineers praise the functional layout of the Model 504, its simple operation and reliable performance.

In short, Hughes finds the Alfred 504 Microwave Amplifiers good, sound, straightforward reliable instruments. We think you will too.

KEY SPECIFICATIONS—ALFRED MICROWAVE AMPLIFIERS

	Model	Frequency Range kmc	Gain db (min)	Power Output (min)	Price
General Purpose Amplifiers for AM, Pulse and Phase Modulation	505	1 to 2	30 db	10 mw	$1,550
	501	2 to 4			$1,390
	503	4 to 8			$1,490
	504	8 to 12.4			$1,490
	549	10.5 to 16			$3,550
Medium Power Amplifiers	5-6752	1 to 2	30 db	1 w	$2,290
	512	2 to 4	30 db	1 w Pulsed	$1,850
			20 db	100 mw CW	
	502	2 to 4	30 db	1 w	$1,390
	5-6868	2 to 4	30 db	10 w	$2,850
	506	{ 4 to 8 4.5 to 7.5 }	27 db	{ .5 w 1 w }	$2,290
	5-542	4 to 8	25 db	1 w	$3,190
	510	8 to 12.4	20 db	100 mw	$2,150
	509	8.2 to 11	27 db	.5 w	$3,150
	5-6996	8 to 9.6	30 db	10 w	$3,590
High Power Amplifiers	5-6826	2 to 4	30 db	1 kw pk	$4,850
Low and Medium Noise Figure Amplifiers	Amplifiers with low and medium noise figures are available either as packaged units or unitized for remote operation of TW tube and solenoid. Standard units provide coverage from .5 to 12.4 kmc with noise figures from 7 db up.				

MANY MODELS TO CHOOSE FROM

The 504 is just one model from the industry's most complete line of microwave amplifiers. For technical details and a demonstration arranged at your convenience, contact your nearby Alfred representative or write direct. Please address . . . Dept. 69.

ALFRED ELECTRONICS

897 COMMERCIAL STREET
PALO ALTO, CALIFORNIA

Circle Reader Service Card 36

NO. 3 OF A SERIES

The Best Microwave Resistors Made Today Are Not For Sale

. . . because we make them only for use in our own precision coaxial attenuators. We are convinced that this is the only way we can assure our customers long-term stability in both field and laboratory applications of our equipment.

Our methods of manufacture and our selection of materials have been developed by extensive experience in making microwave film resistors since 1948. We engage in a continued program of research and development in an effort to find better methods and materials. For this purpose, we maintain a fully equipped laboratory under the direction of a physical chemist.

We produce two types of microwave resistors: noble alloy films and cracked carbon films. Both are deposited on either tubular, disc or strip forms in air-conditioned laboratories under conditions which safeguard against contamination by dust or by contact with human hands.

The resistive film is applied to the insulating base in an extremely thin layer of closely controlled and uniform thickness. The resistors are stabilized and then equipped with coaxial contacts and coated with protective insulation. The resistors are then artificially aged and each individual resistor is tested and inspected between several ageing cycles to reject any that do not meet our standards of stability and accuracy.

The resistors thus produced are characterized by excellent longevity and are virtually insensitive to atmospheric influences. They are able to withstand their rated peak pulse power and provide long, trouble-free service.

Resistor manufacturing in our own plant is just one unique aspect of our production of coaxial attenuators. We have pioneered in the use of stainless steel connectors and barrels. We design our own connectors. And our methods of inspection—incoming, in-process and final—are as painstaking as we can make them. For details, we invite you to write for our brochure, "The Pursuit of Precision."

® WE CO

Specialists in Precision Microwave Calibration Equipment

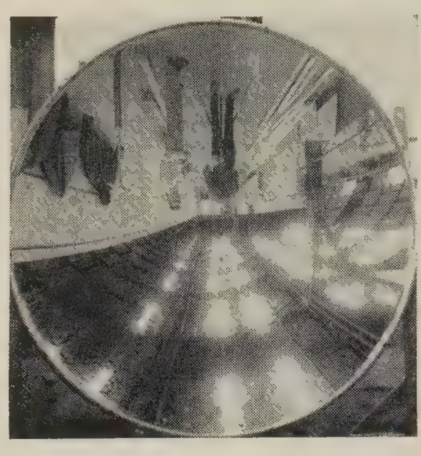
Weinschel Engineering

KENSINGTON, MARYLAND

New Products

(Continued from page 68)

SPINCASTING PROCESS DATA

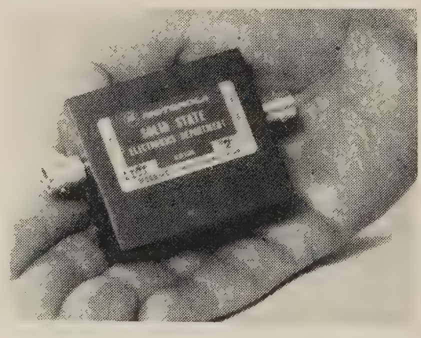


Near-optical surface quality is illustrated by the reflections from this paraboloidal radio mirror. Spincasting antennas of this sort are especially useful as radiators at very high frequency — up to 100,000 mc or better. Shown here is a four foot reflector; larger sizes are available. Data and patterns on Spincasting antennas, taken to 70,000 mc, are available from D. S. Kennedy & Co., Cohasset, Mass., designer and manufacturer of the new type antenna.

Circle Reader Service Card 105

—*mwj*—

MOTOROLA ANNOUNCES FIRST COMPACT UHF ISOLATOR



Adding to its line of advanced microwave ferrite devices, the Motorola Solid State Electronics Department, Scottsdale, Ariz., has announced the first commercially available compact, lightweight isolator designed for operation in the 440 to 470 mc band.

Designated Model LI 01, the new ferrite isolator covers a bandwidth of 30 mc centered at 455 mc, and provides more than 10 db isolation with less than 1.0 db insertion loss, according to John C. Cacheris, microwave components laboratory manager.

The compact isolator measures only 3½ inches x 2½ inches x 1.0 inch. including two BNC connectors, or less than the size of a package of cigarettes. It weighs approximately 8 ounces. In principle, the design characteristics are based on the work Seidel of the Bell Telephone Laboratorie as reported in the April 1959, *Journal Applied Physics.*

The techniques which enable achieveme of the unusually small sizes are expected be used for other Motorola isolators in th range 100 mc to 700 mc, Cacheris said.

Possible applications for the compact iso lator include its use in the laboratory, navigation, telemetry and satellite trackin programs, and in fixed and mobile con munications systems. It also can be used t advantage in optimizing the performanc of parametric and tunnel diode amplifie by stabilizing the gain from changes in a tenna impedance.

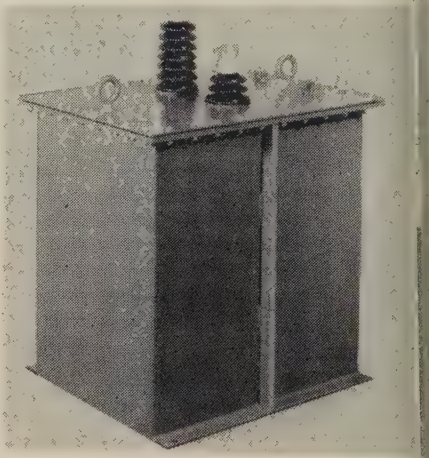
The Model LI 01 UHF isolator is avai able for delivery within 30 to 60 days i production quantities. It is available also other UHF frequencies upon special orde

Additional information and specification are available upon request.

Circle Reader Service Card 106

—*mwj*—

DC CHARGING REACTORS FOR PULSE MODULATOR APPLICATIONS



Custom designed dc charging reactors for pulse modulator applications are now available from Electro Engineering Works, San Leandro, Calif., transformer development and manufacturing firm. These units are used in pulse modulators for klystrons in linear accelerators and high power radar.

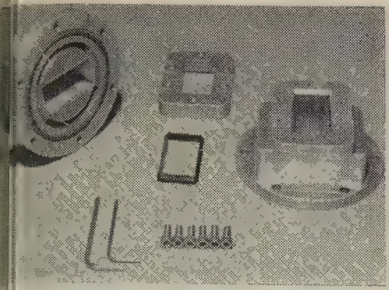
DC charging reactors from Electro may be epoxy resin encapsulated or oil insulated, depending on the requirements. The typical unit shown here is oil insulated and water cooled. It operates at 8 amps dc average current from a dc source voltage of 15 kv, and its peak current rating is 20 amps. Inductance rating is .5 hy and pulse repetition rate for this unit is 800 pps.

Circle Reader Service Card 107

—*mwj*—

◀ **Circle Reader Service Card 37**

WAVEGUIDE FLANGES



icrotech, Inc., a subsidiary of Talley In- ries, Inc., Chesire, Conn., announces development of Waveguide Flanges h are attached to waveguide without ring or brazing.

ccording to George R. Houk, President icrotech, this new flange has electrical acteristics equal to its equivalent brazed ge. The flanges called "Easy-Tach," be attached to waveguide by inexperi- d personnel using only Allen wrenches. ddition to being mechanical and electri- equivalents, the flange is also pressure . After assembly, the flange joint will d more than 230 lbs. straight pull.

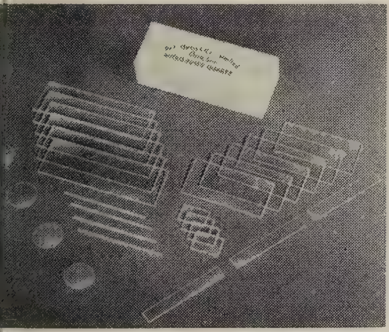
hey are suited for field installations assemblies can be fabricated on the

irst models produced are ETP-137 plate TC-137 choke equivalent to UG-344/U UG-343/U respectively. They will be lable in either aluminum or brass.

ircle Reader Service Card 108

—*mwj*—

MICRO-FUSED QUARTZ FOR NFRARED, MICROWAVE AND ANALYTICAL APPLICATIONS OFFERED



The Dell Optics Co., West New York, J., now makes available Micro-Fused artz in optical grades.

This precision-fabricated quartz finds de application for infrared, micro- ve and in analytical applications. cro-Fused Quartz is precision fabri- ed by Dell specialists and is available very thin plates, optically ground and lished flat. Seven thicknesses are sup- ed ranging from .003″ to .021″. unds, squares and rectangulars are plied up to 4″.

Circle Reader Service Card 109

(*Continued on page 73*)

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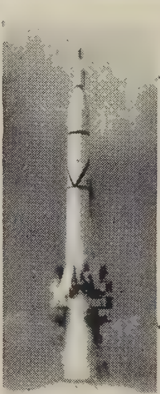

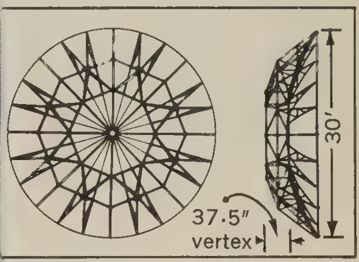

This precision 30-foot antenna has a more accurate surface than any other production parabolic reflector of comparable size.

Antenna System's new solid surface, high precision 30-foot antenna (model 103) is designed to set a new standard for accuracy in the fields of radio astronomy, tropospheric scatter propagation, tracking radar, and experimental test installations. It features:

- High precision — The static surface tolerance of the first unit has been measured. The deviation from the ideal curve measured 0.033 inches RMS.
- Has an f/d ratio of 0.417 which readily adapts to a wide variety of feed systems.
- Fully machined sections are interchangeable and easy to assemble.
- Solid surface panels permit use at any frequency.
- Useable with a wide variety of feed support systems.
- Built to withstand 150 MPH wind with 4″ ice.
- Can be mounted on either the top or side of a tower with azimuth and elevation adjustments, on el-az or equatorial pedestals, self-contained trailer tower mounts, or other types of mounts.

Write for specification sheet.

DESIGNERS AND MANUFACTURERS OF ANTENNA SYSTEMS

ANTENNA SYSTEMS INC. HINGHAM, MASSACHUSETTS

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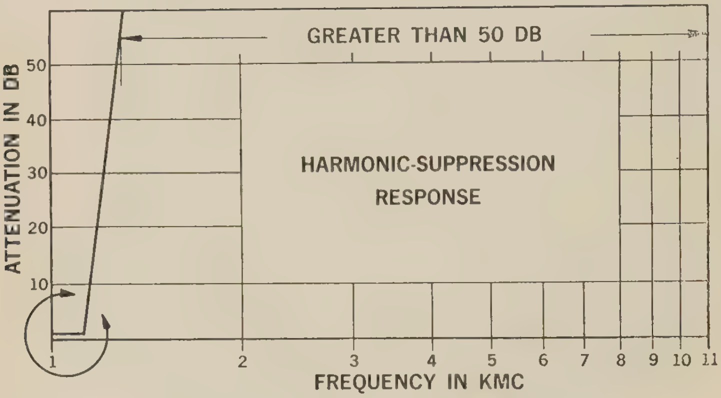
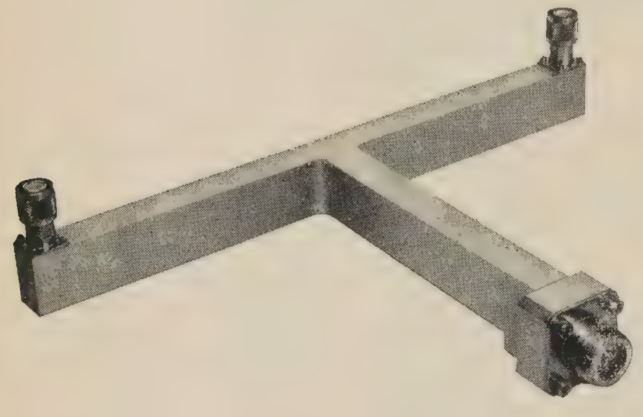
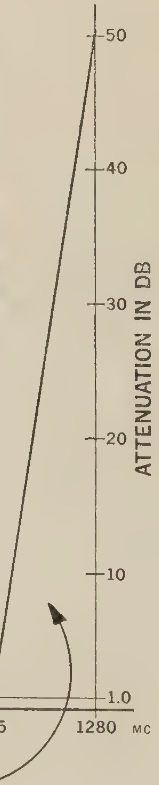
MC Power Dividers

FREQUENCY-SELECTIVE, PHASE- and AMPLITUDE-TRACKED POWER DIVIDER



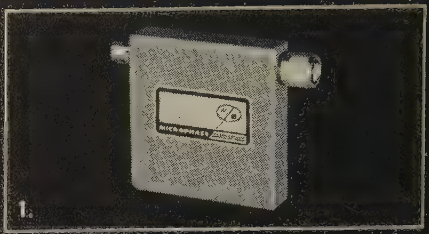


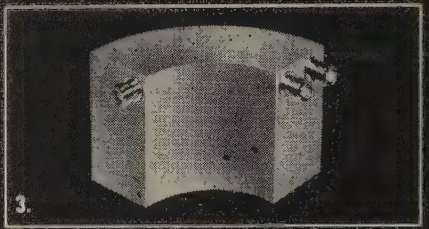


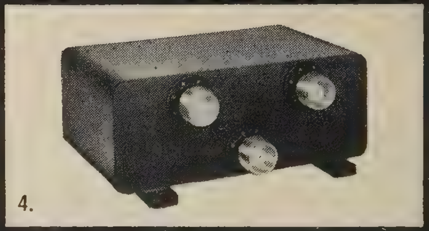
PERFORMANCE CHARACTERISTICS

Frequency Range	1015-1105 mc
Total Insertion Loss	1.0 db max
Phase Tracking	3° max between output arms
Amplitude Tracking	±0.1 db max in output arms
Input VSWR	1.25:1 max
Input-Signal Harmonic Suppression	50 db min (1280-11,000 mc)
Power Capacity	30 kw peak power

Units with unequal power division may be supplied. Multiple-output power dividers are also available from MICROPHASE







1. Band-Pass Filter with a band width of 50-100 mc. Input and output impedances are 200 Ohms. 1.5 db maximum insertion loss and 60 db minimum attenuation at $0.85f_{c1}$ and $1.15f_{c2}$.
2. Plug-in type S-Band Band-Pass Filter has a nominal 50 mc band width. Used in a counter-measures front end. Provides 30 db isolation at f_o ±50 mc.
3. UHF Diplexer for missile applications. Crossover-frequency is 380 mc. Insertion loss in the pass band is 1.5 db max. Pass-band widths are 6 mc, and minimum isolation between channels is 60 db.
4. IFF/TACAN Diplexer. This units meets all requirements of MIL-F-25880A. It is interchangeable with F-339/A Band-Pass, Band-Suppression, Filter.

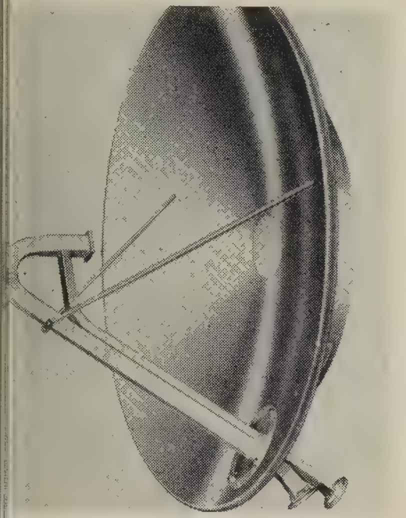
MICROPHASE
CORPORATION

Box 1166W Greenwich Conn. NO 1-6200 WE 9-9190 Teletype: GREENWICH CONN. 759

Circle Reader Service Card 39

(*Continued from page 71*)

UAL POLARIZED MICROWAVE ANTENNAS



A series of dual polarized 6 kmc an- nas is now offered by Andrew Corp., icago, Ill., manufacturers of antenna tem equipment. These antennas com- e two microwave signals in a single enna. The two signals are fed to the enna by independent waveguides. This gn eliminates the need for circulators, uces tower windloading, installation maintenance cost.

he mechanical specifications of these ennas are similar to those for com- rable sizes of the Andrew plane polar- d 6 kmc antennas. Antennas are of- ed in 4, 6, 8 and 10 foot sizes.

Circle Reader Service Card 110

—*mwj*—

PYROFILM ANNOUNCES NEW GH POWER ATTENUATOR DISCS

Pyrofilm Resistor Company, Parsip- ny, N.J., announces a new line of high wer, deposited carbon film coaxial at- nuator discs, designed for low and high equency use, which allow more power ssipation per unit area at higher pulse ltages. Ideal for use in terminations, tenuators, coaxial line attenuators and aveguide attenuators. Solderable silver ated terminals allow rigid assembly ithout the use of pressure clips. The tenuators are protected by varnish that thstands 200°C for prolonged periods hile offering resistance to humidity and effect from shelf aging. Derating rve is linear from full power at 70°C zero power at 150°C. Sizes and elec- ode configuration are held to customer quirements. Available in ceramic, alu- ina and vycor cores. Availability, one eek.

Circle Reader Service Card 111

(*Continued on page 74*)

—*mwj*—

Mounts Available To Fit:
- TUNNEL DIODES
- VARACTORS
- MICROWAVE TRANSISTORS
- MINIATURE DIODES
- FAST-SWITCHING TRANSISTORS

MODULAR
SANDERS TRI-PLATE® MOUNTS NOW AVAILABLE FOR ADVANCED SEMICONDUCTORS

This new Sanders strip transmission line development allows you to design the most advanced semiconductors into such applications as parametric amplifiers, harmonic generators, and transistor circuits.

Sanders Semiconductor Mounts are an important addition to the present line of on-the-shelf Tri-Plate strip transmission modules . . . and now permit designers to breadboard *almost any* microwave circuit in a matter of minutes. For complete specifications, prices and delivery schedules on Semiconductor Mounts or standard Tri-Plate module kits write today.

®Trademark Sanders Associates, Inc.

SANDERS ASSOCIATES, INC.

Product Manager, Microwave Products Dept., NASHUA, NEW HAMPSHIRE

Circle Reader Service Card 40 ➧

(Continued from page 73)

BENDIX DEVELOPS NEW FERRITE LINE

A new line of ferrite devices is now available from the Red Bank division of The Bendix Corporation, Eatontown, N. J.

The first three components of the line, which Bendix engineers say represents advanced concepts in microwave devices, consists of a C-band electrically variable attenuator (Model TFA-1), a C-band electrically variable phase shifted (Model TFP-1), and a C-band Y circulator (Model TFC-1).

Features of the units include broad bandwidth, low insertion loss, wide temperature range, and small size and low weight.

Model TFA-1 attenuator has an extensive range of attenuation that is inversely proportional to solenoid current over a wide range, low current requirements, and a fast response time. The attenuation range exceeds 25 db from 4900 to 5800 mc. The insertion loss is less than 1.0 db, and it will operate over a temperature range from minus 55°C to plus 125°C. It can handle three watts average power and three kw peak power. The TFA-1 is 1.12 inches in diameter, 3.18 inches in length, and weighs six ounces. Applications include use in fast AGC circuits, remote level-control systems, and service as a modulator or a fast-acting switch.

Model TFP-1 phase shifter, which als features low current requirements and fast response time, provides a phase shif range from 0 to at least 90 degrees over bandwidth of 5200 to 5800 mc. Its insertio loss is less than 1.0 db with a VSWR o less than 1.20.

The TFP-1 operates over the same tem perature range as the TFA-1, and has th same physical dimensions, weight and powe handling capacity. It can be used as a phas modulator or, in certain applications, as fast-acting switch, as well as in RF directio finding applications.

The TFC-1 Y circulator has a minimum isolation of 22 db and can handle an averag power of 10 watts and a peak power of 10 kw. The unit, which operates in the 4700-5700 mc range, has a maximum insertion loss of 0.4 db with a VSWR of less than 1.15. Its height is 1.9 inches with a diameter of 2.375 inches (less connectors). The TFC-1 will operate over the same temperature range as the other two components. The unit can be used in many missile and space vehicle applications, and with masers and parametric amplifiers. It also can serve as a broadband isolator.

These ferrite devices were developed by the Research Laboratories division of the corporation.

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for reliability, stability and uniformity specify

FILMOHM

microwave resistors

FILMOHM Metal Film Resistors offer: high stability • low temperature coefficient • tinned electrodes • micro-thin resistance film (even at highest frequencies) • quality-controlled dimensions, electrical and high temperature characteristics. Choose from a wide variety of shapes, sizes and base materials for a precision-engineered FILMOHM Microwave Resistor to suit your requirements.

•

FILMCARD
Metal film Fibreglass resistance card for all low power attenuators and terminations. Available in a wide range of resistivities. Easily fabricated. Ask about new FILMCARD KIT. **Bulletin P-2.**

COAXIAL DISCS AND RODS
Metal resistance film fused to PYREX base, sealed with micro-thin quartz coating. From BNC to largest line size. **Bulletin M-1-1.**

METALLIZED GLASS ATTENUATOR ELEMENTS
Standard plates available for L through K bands. **Bulletin A-1.**

FOTOCERAM* ATTENUATOR ELEMENTS
Ruggedized precision attenuator elements. Withstands severe shock and vibration. **Bulletin FCA-1.**
*Reg. T.M. Corning Glass Wks., Corning, N. Y.

FILMOHM METALLIZED MICA
For use as rotary and guillotine attenuator elements. Ideal for mm. frequencies. Available in large sheets or fabricated parts. From .001″ to .005″ thick. **Bulletin C-1.**

COAXIAL TERMINATION RESISTORS
Metal film, ceramic base resistors for 3/8″ line coaxial terminations. Useable up to 10 KMC. **Bulletin CT-1.**

CERAMIC DISC RESISTORS
New, low cost, ruggedized disc resistors for coaxial terminations. **Bulletin CD-1.**

FLEXIBLE RESISTANCE CARD
Completely flexible thin plastic resistance card. May be laminated to cavities for use as mode suppressors. **Bulletin FR-1.**

HI-POWER COAXIAL LOAD RESISTORS
Metal film tubular glass resistors, non-inductive, for dummy loads and terminations. Standard and special sizes to 2′ long. **Bulletin HP-1.**

STRIPLINE RESISTORS
Mica-base resistors as thin as copper stripline. Cement directly into stripline circuits. **Bulletin SL-1.**

MICRO-MODULE RESISTORS
Available on special order utilizing glass, ceramic or mica base. Custom-designed to suit your microminiature applications. **Bulletin FRC-4.**

OTHER PRODUCTS AVAILABLE
FLEXIBLE DISC RESISTORS • METAL FILM CERAMIC TUBULAR RESISTORS • CRYSTAL RESISTORS

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reaching out with TRG
INCORPORATED

MICROWAVE HARDWARE 30-140 KMC

Available for 60-75 KMC from stock or to your specifications.

EXCLUSIVE

FERRITE ISOLATOR

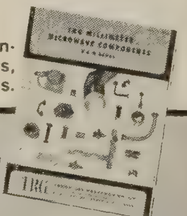
The Model V-FL1 Ferrite Isolator operates as a non-reciprocal 45° rotator with a permanent magnet supplying the bias field. An integral 45° waveguide twist provides alignment between the input and output waveguide polarizations.

SPECIFICATIONS FOR 3% BANDWIDTH

VSWR: 1.3 max.
Loss < 0.7 db
Isolation: > 17db

Length: 2 inches
Pressurization: 30 P.S.I.
Finish: Baked blue enamel

WRITE FOR NEW CATALOG 160A for details on Ferrite Components, TE$_{01}$ Mode Circular Waveguide Components, Hybrid Mixers, Crystal Holders, Feed Horns, Dishes, Electroformed Transitions.



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TECHNICAL RESEARCH GROUP
Syosset, New York • Somerville, Mass.

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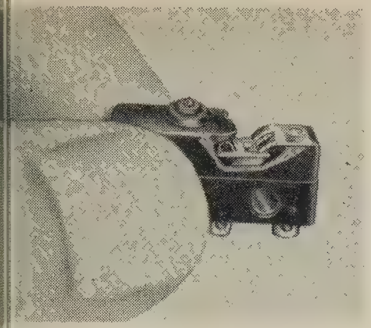
OOST SWITCH RELIABILITY



rcated gold contacts — for in-
d switch reliability and stabilized
t resistance in data processing,
and radio circuits — are a feature
ew subminiature snap-action switch
nced by Micro Switch, Freeport,
ivision of Minneapolis-Honeywell
ator Co.

d in dry (extremely low-energy)
ts, these gold contacts offer low
nce with greater life and reliability
teristics in millivolt and milliam-
ircuits.

bifurcated contacts (two contact
s in each position) move with a
g action to clean the surfaces with
cycle.

trical rating of the single-pole
e-throw switch is 5 amps at 30
ic. Switch weight is .006 pounds,
ing force 3 to 5 ounces, dimen-
1/4 inch by 1/2 inch by 3/4 inch.

cle Reader Service Card 113

— *mwj* —

ROWAVE MIXER-PREAMPLIFIER ASSEMBLY

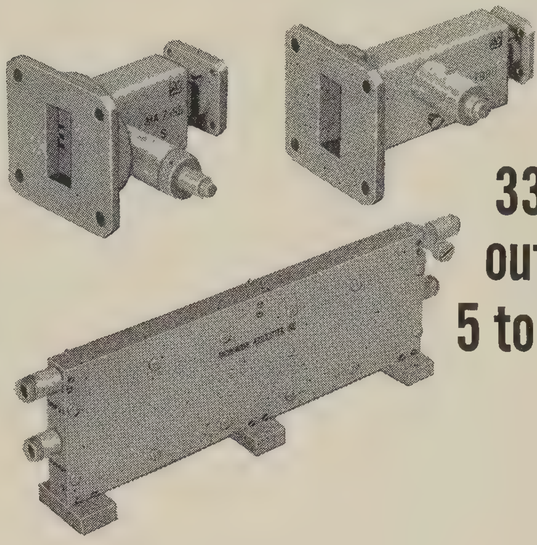
new addition to LEL's series of mi-
ave receiver head-ends, the MMK-1
ed-mixer assembly covers a fre-
y band from 15.0 to 17.0 kmc, has a
nal bandwidth of 8 mc, and a noise
of 9 1/2 db. Gain is 25 db, and
milliwatt of local oscillator power
quired.

rcle Reader Service Card 114

— *mwj* —

(*Continued on page 76*)

UNPRECEDENTED EFFICIENCIES IN HARMONIC GENERATION . . .



11 kMc input @ 500 mw

33 kMc output @ 5 to 20 mw

Nine new examples of Microwave Associates' capabilities in the design of harmonic generators are available now. These models feature exceptionally high output power with conversion losses well below existing devices.

New designs incorporating solid state elements can be used to eliminate costly klystrons, DC bias supplies and high voltage power supplies. All units feature broadband fixed-tuned operation, filters eliminating unwanted harmonics, and versatile coaxial, waveguide and strip-line packaging.

These models are typical examples of our progress to date . . . presently we are working for even greater efficiencies and performance. Additional models in development converting 1 watt at 2000 Mc to 100 mw or more, at 4000 and 6000 Mc, to be announced soon.

Your specific application problems are of prime interest to us. Our Applications Engineers would welcome the opportunity to design harmonic generators to meet your specifications.

SPECIFICATIONS

	INPUT				OUTPUT				
Model	Connector Type UG-	Frequency Input kMc/s	Band	mw input	Connector Type UG-	Frequency Output kMc/s	Band	Conversion Loss (max.)	Output mw
MA796	23/U	0.26 — 0.28	P	20	23/U	1.30 — 1.43	L	13db	1
MA797	23/U	1.30 — 1.43	L	100	23/U	5.22 — 5.72	C	15db	3
MA798A	39/U	9.0±150Mc	X	500	596/U	18.0±300Mc	K	17db	10
MA798B	39/U	10.0±150Mc	X	500	596/U	20.0±300Mc	K	17db	10
MA798C	39/U	11.0±150Mc	X	500	596/U	22.0±300Mc	K	17db	10
MA798D	39/U	12.0±150Mc	X	500	596/U	24.0±300Mc	K	17db	10
MA799A	39/U	9.0±100Mc	X	500	600/U	27.0±300Mc	Ka	20db	5
MA799B	39/U	10.0±100Mc	X	500	600/U	30.0±300Mc	Ka	20db	5
MA799C	39/U	11.0±100Mc	X	500	600/U	33.0±300Mc	Ka	20db	5

Write or call:
MICROWAVE ASSOCIATES, INC.
BURLINGTON, MASSACHUSETTS
Western Union FAX-TWX: Burlington, Mass., 942 • BRowning 2-3000

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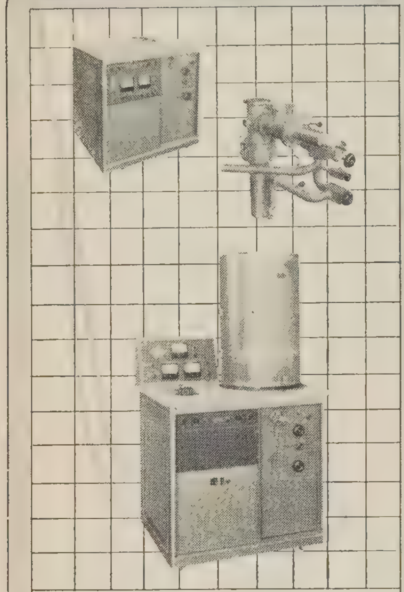
(Continued from page 75)

You're guaranteed 10^{-6} mm Hg *fast* with . . .

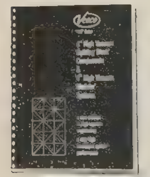


THE MODULAR "400" SERIES 4" VACUUM SYSTEMS & EVAPORATORS

GUARANTEED PERFORMANCE:
5×10^{-6} in 45 sec.
Less than 5×10^{-7} ultimate (blanked port)
5×10^{-6} in 4 min.
Less than 10^{-6} ultimate (18" x 30" Bell Jar)

MODULAR CONSTRUCTION:
Buy exactly what you need, from basic plumbing to complete Evaporators and Bakeout Systems. Incorporate additional equipment as your requirements grow.

TROUBLE-FREE PERFORMANCE:
Each VE-400 System undergoes a full week (168 hrs.) of test run and inspection before shipment.



FREE "400" SERIES BROCHURE contains complete performance data and design specifications on the 4" building block components and modular systems. Write Department A-1436.

Veeco VEECO VACUUM CORP.
86-B Denton Avenue, New Hyde Park
Long Island, New York
HIGH VACUUM & LEAK DETECTION EQUIPMENT

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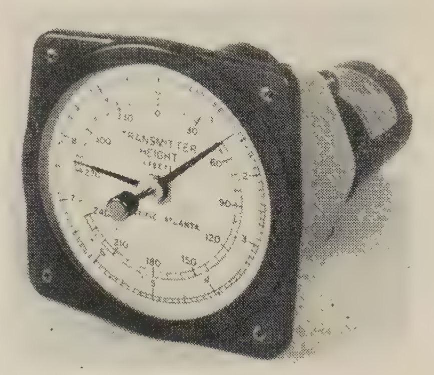
NEW DUAL-POSITION SYNCHRO INDICATORS



Two new Dual-Synchro Position Indicators designed for extremely accurate, non-ambiguous remote indication of linear or angular position of transmitter units are now available from Scientific-Atlanta, Inc., Atlanta, Ga.

S-A's indicators use two synchro receivers which combine the advantages of both the 1:1 and the 36:1 synchro indicators. separate synchro receiver is geared to ea pair of concentric dial pointers.

The Atlanta firm's Models IU-3 and IU 6 can be read accurately within ±0.03 d gree. The units offer instant, visual positic indication from a 5-1/4 inch panel moun ing.

The Model IU-3 is used when conditior require resetting to zero with respect to a arbitrary reference point on the mechanisı being monitored. The Model IU-6 used when monitoring a mechanisı having a fixed reference point.

Series IU indicators are companions fc Scientific-Atlanta Series PX 1 Synchr Transmitter Units. Together, these compc nents can be calibrated to read out angle height, linear distance, or any other quantit that can be measured by shaft rotations o linear displacement. S-A engineers will de sign specialized systems.

Circle Reader Service Card 115

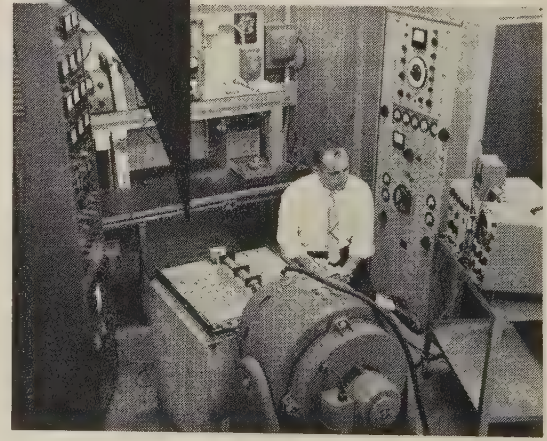
—*mwj*—

RUGGEDIZATION

TRAVELING WAVE TUBES

Tests prove that Huggins TWT's can be provided to operate at 30G shock; 90,000 ft, altitude; 10G vibration to 2000cps with 0.5DB max. amplitude modulation; −55°C to +71°C with ±2DB variation in gain.

Huggins HA 20 undergoes Vibration tests



A world leader in research and production of TWT's, the Huggins line is applicable to all phases of military equipment . . . ground, shipboard, and airborne.

Whatever your project, if it involves TWT's, call on Huggins for complete assistance.

HUGGINS manufacture development engineering design research LABORATORIES

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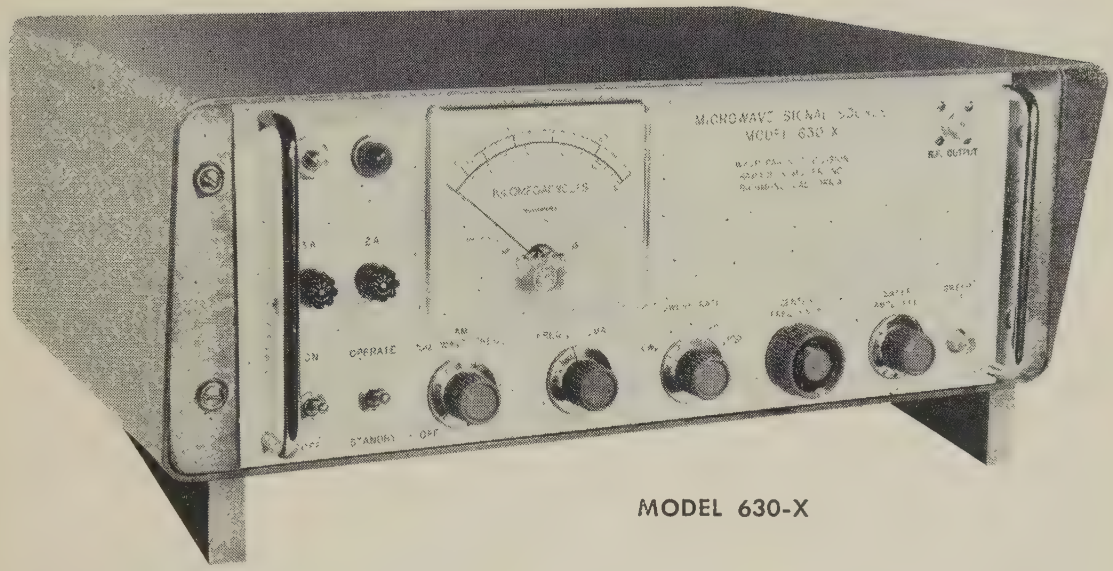
SEE US AT WESCON

A NEW
ELECTRONICALLY SWEPT SIGNAL SOURCE



MODEL 630-X

WAVE PARTICLE offers a complete line of electronically swept microwave signal sources which cover the entire frequency range from 0.98 to 75.0 KMC. Uniquely engineered and designed, the instruments combine truly remarkable features that satisfy the most demanding requirements.

MODEL 630-X
8.2 - 12.4 KMC

Power Output . .	20 mw. (minimum)
Sweep Rate . . .	C.W. or 0.1-100 CPS
Sweep Width . .	A Few MC. to 4.2 KMC
A.M. Modulation .	800-1200 CPS Square Wave
Sweep Output . .	Linear Sawtooth
Oscillator . . .	Varian VA-161
Price	$2,850.00
Delivery	2-4 weeks

- ▶ LIGHT WEIGHT, ONLY 28 LBS.
- ▶ SIMPLE TO OPERATE. A MINIMUM OF CONTROLS SIMPLIFIES OPERATING PROCEDURE
- ▶ COMPACT DESIGN. ONLY 7″ x 19″ PANEL AREA.

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Needham 92, Mass.
Hillcrest 4-1142

East
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Tuckahoe, New York
Woodbine 1-4700

Circle Reader Service Card 46

High-Power Microwave Absorber Ceramics

From CFI's fully integrated ceramics service come the new 1000 Series microwave absorber ceramics.

Typical performance from 1000 Series ceramics shows exceptionally high losses of 9.05 db/cm at 25 deg. C. and "uniform" attenuation over an extremely wide range of frequencies. What's more, these new microwave ceramics are stable in air or vacuum at high temperatures in excess of 1,000 deg. C. in both low and high power systems.

For complete details on the 1000 Series and other custom-designed ceramics and ceramic-to-metal composites for your precise microwave specifications, call CFI today.

Send for free CFI ceramics data

CFI *An Integrated Ceramics Service*

CFI Corporation
Department MJ, Cottage Place
Mineola, New York—Pioneer 6-0571

Gentlemen: Please send me, without obligation, the following literature on CFI ceramics:
☐ "Custom Ceramic Parts for Industry" Brochure
☐ Microwave Ceramics Spec Sheet
☐ Have technical representative contact me.

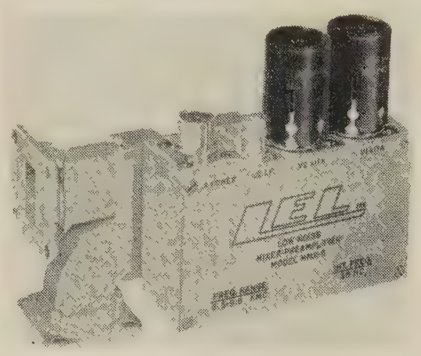
Name__________
Title__________
Company__________
City______Zone______State______

◀ Circle Reader Service Card 47

New Products

(*Continued from page 76*)

LEL MODEL MMX-6 MICROWAVE RECEIVER ASSEMBLY



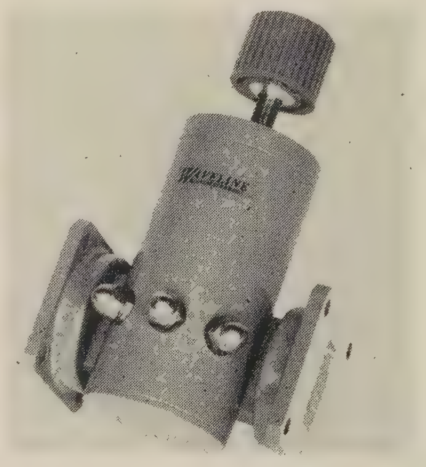
LEL, Inc., Copiague, N.Y., announces the MMX-6, a new matched X-band microwave receiver head end assembly covering the 8.5 to 9.6 kmc range with a maximum noise figure of 7.5 db, and a typical noise figure of less than 7 db. IF bandwidth is 8 mc and IF gain 25 db.

The MMX-6 is electrically similar to the MMX-2 introduced earlier but has been improved mechanically to provide rugged design at lower cost.

Circle Reader Service Card 116

—*mwj*—

TUNABLE WAVEGUIDE FILTER



Waveline, Inc., Caldwell, N.J., has developed a tunable single section dual mode Band Pass filter for operation in the 8.5 to 9.6 kmc range.

This single section filter is tunable over the range of 8.5 to 9.6 kmc and has a 3 db bandwidth which varies from 29 to 36 mc over the band. The insertion loss at Fo —60 mc is 21 db minimum.

This unit identified by Waveline part number 60017 is manufactured in aluminum and has been designed to withstand severe shock and vibration environments. The sertion length or dimension from flange flange is 2.75 inches and tuning is acco plished through a precision micrometer ty drive screw with a positive locking devi

The unit described is one of several typ of waveguide filters available from Waveli Inc. Other designs for use in a wide ran of frequency bands in waveguide and coaxi configurations are available and can furnished to meet specific systems applic tion requirements.

Circle Reader Service Card 117

—*mwj*—

ITT SUPER POWER CERAMIC HYDROGEN THYRATRON

ITT Components Division, Clifton, N.J., announces the availability of Kuthe Type KU-74, a new ceramic-metal hydrogen thyratron.

This tube has been specifically designed to meet the requirements of long pulse, high average power radars. Rated at 33 mw peak power this tube is capable of operation at an average anode current of 4.0 amps at an RMS value of 90 amps.

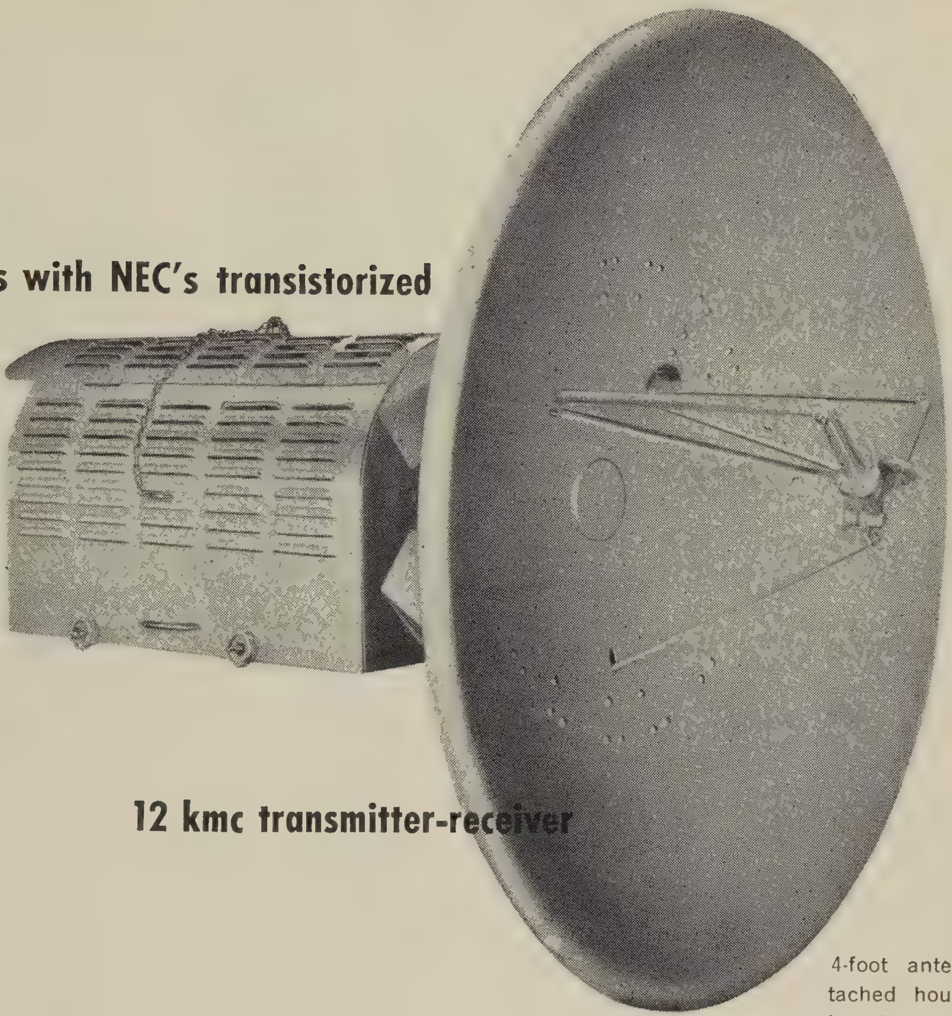
Design features of the KU-74 include the use of internal heat sinks to maintain proper temperatures of the grid and reservoir. In addition, a unique anode design prevents local hot spotting of the anode. No artificial cooling of this tube is necessary under ordinary ambient condition during full power operation. The KU-74 is available for immediate shipment.

Circle Reader Service Card 118

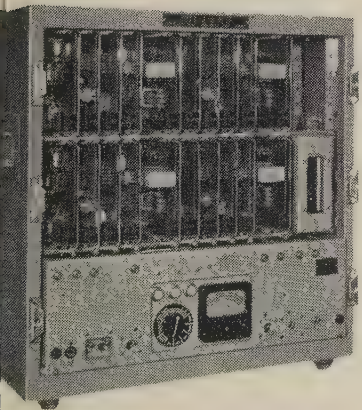
— *mwj* —

(*Continued on page 80*)

New application for nicrowave links with NEC's transistorized 12 kmc transmitter-receiver



4-foot antenna and attached housing for 12 kmc transmitter-receiver.



erminal bay contains channel e-
uipment and power supply panel.

This equipment is designed as a short-haul multi-channel telephone, remote control, and telemetering link for use especially at locations with difficult access. Circuits are fully transistorized except for a single klystron. Power consumption is 30 W.

Though not designed as portable equipment, it is so compact and lightweight that it is adaptable for use in emergency and disaster communications. It also makes a low-cost temporary communications link such as required at a construction site.

Summary of features : ● Operates at 12 kmc, where the spectrum is relatively uncrowded and antenna gain is high. ● Single reflex klystron (VA92C equivalent) is used for both transmitter and receiver local oscillator. ● Pole-mounted transmitter-receiver with ERP of 100 mw. ● Operates from commercial power line or 24 dc volts. ● Provides 4 am or 12 ssb telephone channels. Carrier equipment available to provide up to 60 ssb telephone channels.

NEC *Nippon Electric Co., Ltd.* Tokyo, Japan

Communications Systems / Electronics

WESCON Show Booth No. 2412-2413.

Circle Reader Service Card 48

MICROWAVE Kearfott PRODUCTS

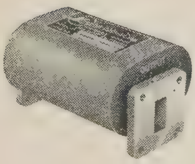
FERRITE ISOLATOR

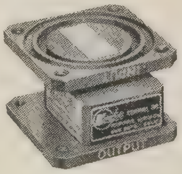
The all new Model WD-2106 Octave S-Band Isolator marks a revolutionary advancement in the microwave field by permitting the use of only one isolator for a full octave frequency range instead of covering the band in increments using a number of isolators. Ideal for use in telemetry, radar systems and transponders, the new unit offers exceptional reliability, excellent isolation to insertion loss characteristics and compactness of design.

TYPICAL SPECIFICATIONS

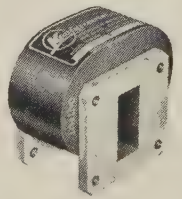
MODEL	FREQ. RANGE	ISOLATION	INSERTION LOSS	V.S.W.R.
WD-2106	**2.1-4.3 KMC**	**20 DB Min.**	**2.0 DB Max.**	**1.5 Max.**
W-568-3A-2	12.5-18.0 KMC	20 DB Min.	1.0 DB Max.	1.15 Max.
W-177-1K-1	9.5 KMC ± 100 MC	25 DB Min.	.7 DB Max.	1.15 Max.
W-277-3A-3	5.2-5.9 KMC	17 DB Min.	1.0 DB Max.	1.15 Max.
W-668-1A-2	8.5-9.6 KMC	10 DB Min.	0.4 DB Max.	1.10 Max.

THESE ARE ONLY A FEW OF THE MANY AVAILABLE MODELS


W-568-X


W-177-X

W-277-X


W-668-X

Inquiries may be directed to: 14844 Oxnard Street, Van Nuys, California

KEARFOTT DIVISION

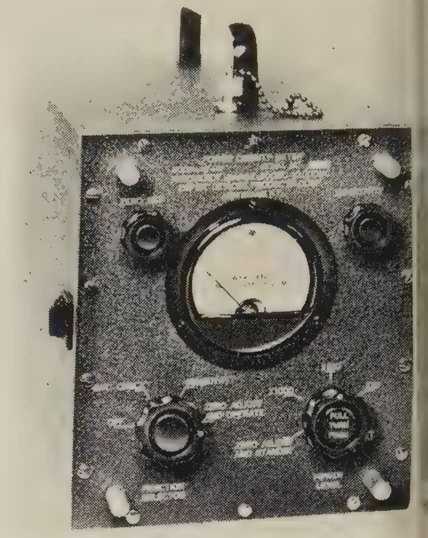
GENERAL PRECISION INC.
LITTLE FALLS, NEW JERSEY

Circle Reader Service Card 49

New Products

(*Continued from page 78*)

NEW BROADBAND POWER DENSITY METER OFFERED BY EMPIRE DEVICES



A direct-reading meter, used with on of three constant-gain calibrated probes now permits speedy and precise determination of RF power density. Designated Model NF-157, and made by Empire Devices Products Corp., Amsterdam, N. Y., the broadband indicating device is capable of reading power density from 0.1 mw/cm^2 to 2000 mw/cm^2 over the continuous frequency range from 200 to 10,000 mc.

Using small batteries as a power source, the basic measuring unit weighs but 10 pounds, and the physical separation of probes from the main unit increases the flexibility of application Recommended applications include: indication of personnel safety in high density RF fields; near-field intensity measurements; measurement of absolute power from 0.1 milliwatt to 2 watt; and the detection of hot spots and leakage near antennas, feeds and other high power components.

In operation, power densities (watts/cm^2) are converted by the probes to corresponding power levels in watts, then fed to an appropriate attenuator as chosen by the power level setting of the unit. Attenuated power is measured by a thermistor element incorporated in a temperature-compensated dc bridge. Power detected by the thermistor changes the operating condition of the bridge, thus enables power density to be shown directly on an indicating meter. A self-calibrated feature permits checking of zero balance and bridge sensitivity at all times.

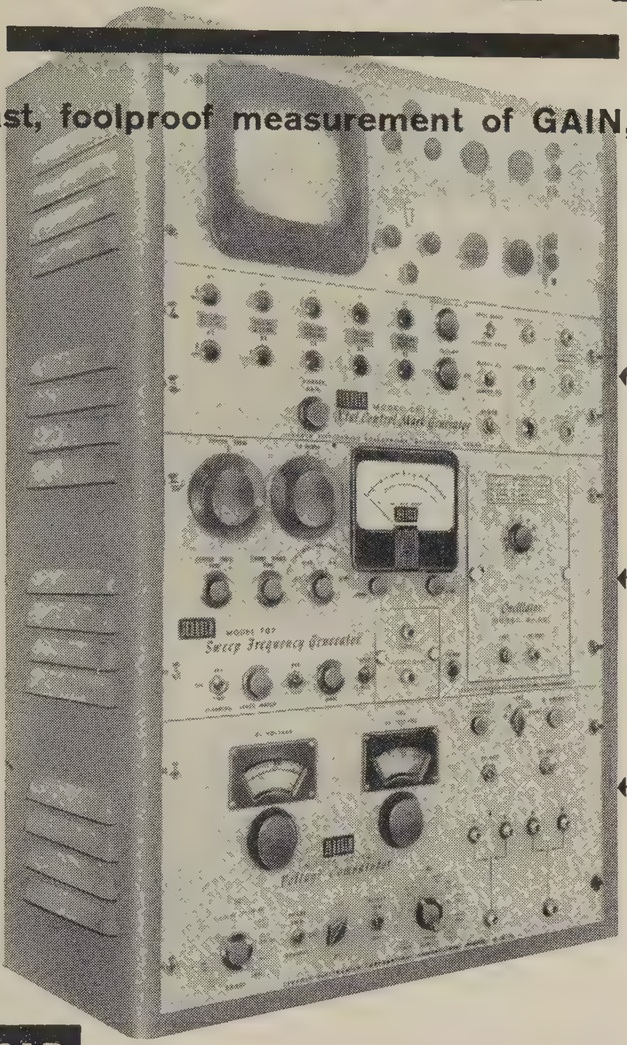
Circle Reader Service Card 119

—*mwj*—

(*Continued on page 82*)

BEST TEST SET YET!

For fast, foolproof measurement of GAIN, LOSS, VSWR, Q, X_L, X_c, Z



Crystal Controlled Marker Generator

Model CM-10—A 10-crystal unit producing any selected fundamental and/or harmonic frequencies. Each oscillator has its own independent amplitude control. Features built-in scope pre-amplifier and VSWR filter.

Precision Sweep Generator

Model 707—The heart of the test set. Features an extremely flat RF output (±5/100 db) and variable rate, all electronic sweep with plug-in oscillators available covering 2 to 265 mcs. Provisioned for use with an X-Y plotter.

Accurate Voltage Comparator

Model VC-12 — The unit that makes Measurement By Comparison possible. A 3-section instrument that contains regulated DC and RF voltage supplies and a wide band coaxial comparator for the simultaneous visual presentation of reference standards against which the test information is compared.

Model 1707 Price **$1,570.00**
(Oscilloscope, rack, or recorder not included)

JERROLD MODEL 1707

Complete RF TEST SET employs the **M**easurement **B**y **C**omparison technique

Interested in more than one frequency . . . an entire band, octave, or spectrum? Now it's no longer necessary to employ the slow, tedious, point-by-point method of measurement when working with a spectrum of frequencies. Jerrold's new 1707* test set will do the same measurement job *Faster*, more accurately, and with fool-proof results. Featuring the **M**easurement **B**y **C**omparison technique, the model 1707 provides a continuous visual presentation and self calibration against precision standard attenuators (and/or accurate DC and RF voltage sources referenced against a standard cell). So, whatever your laboratory, production, or field needs—Jerrold's sweep frequency **MBC** method will serve them better.

Write today for complete catalog and technical newsletter series on MBC procedures.

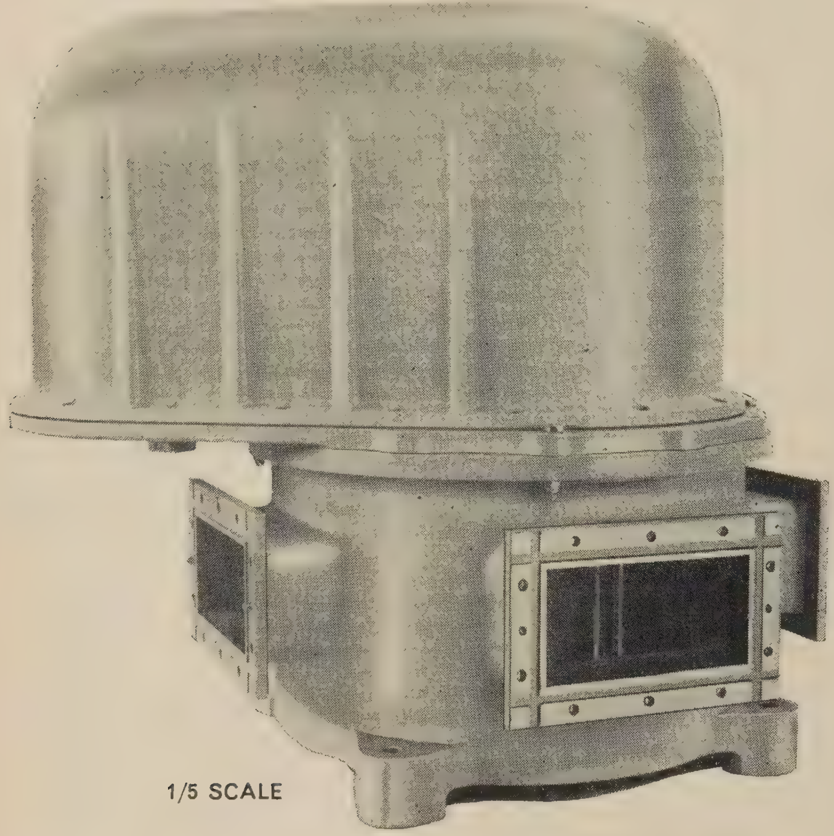
JERROLD ELECTRONICS CORPORATION
Industrial Products Division, Dept. ITE-61, Philadelphia 32, Pa.
Jerrold Electronics (Canada) Ltd., Toronto • Export Representative: Rocke International, N.Y. 16, N. Y.

WESCON BOOTHS 426-427

*Similar test sets available for other ranges

Circle Reader Service Card 50

SPLIT



PERSONALITY

IT'S BIG! Our new high power L-Band Switch has a waveguide cross section of 3¼″ by 6½″. It provides quite high electrical isolation between the two RF channels. Minimum guaranteed isolation is 80db. Air pressure can be maintained in one RF channel while the other channel is unpressurized. It maintains pressurization during the switching cycle when it automatically shuts off one transmitter and turns on the second transmitter as soon as the VSWR is in the proper limits. In the normal operating position, this new Airtron Switch has a VSWR of less than 1.10. Send today for complete specifications.

AIRTRON
A DIVISION OF LITTON INDUSTRIES

PACIFIC COAST FACILITY 5873 RODEO ROAD, LOS ANGELES 16, CALIFORNIA
GENERAL OFFICES MORRIS PLAINS, N.J.

Circle Reader Service Card 51

New Products

(*Continued from page 80*)

TRANS TECH INTRODUCES A NE MICROWAVE GARNET

A much sought after polycrystall garnet material has been developed the research facilities of Trans Te Inc., Rockville, Md. The new garnet the first of its kind with such a low electric loss at microwave frequenci The special ceramic process was veloped by Robert L. Huntt of t Trans Tech Research Department.

The first material to be released h an X-band dielectric loss tangent (T z — e″ / e′) of less than 0.0005. other characteristics are similar to star ard stoichiometric Yttrium Iron Garn The new material is type TT G-1600.

The improved garnet is available bar form 1 inch x 1/2 inch x 6 inch having the following electronic prope ties: saturation magnetization 16 gauss; Curie temperature, 264°C; electric constant, 15.3; gyromagne resonance line width, less than 50 o steds and effective gyromagnetic rati 1.99.

The large dielectric constant, great magnetic activity, narrow resonance li width and low dielectric loss of this m terial facilitates designing smaller co ponents in the C and X band region ha ing a higher merit figure than is pos ble with conventional ferrites.

Additional data on this product well as other materials is available upo request.

Circle Reader Service Card 120

—*mwj*—

NEW MINIATURE RF CONNECTOR INTRODUCED BY GREMAR MANUFACTURING COMPANY

Gremar Manufacturing Co., Inc Wakefield, Mass., announces the avai ability of its new Red Line series o miniature RF connectors. They are hal the weight and size of standard TN connectors with no sacrifice of perform ance or reliability.

Designed for use with the new MIL type subminiature coaxial cable, the Re Line series introduces a patented, low reflection, metal-to-metal cable clampin method which eliminates the necessit of combing out cable braid, saving u to 80 per cent of assembly time, an assuring a lower, more constant VSW than is achieved with conventiona methods of clamping.

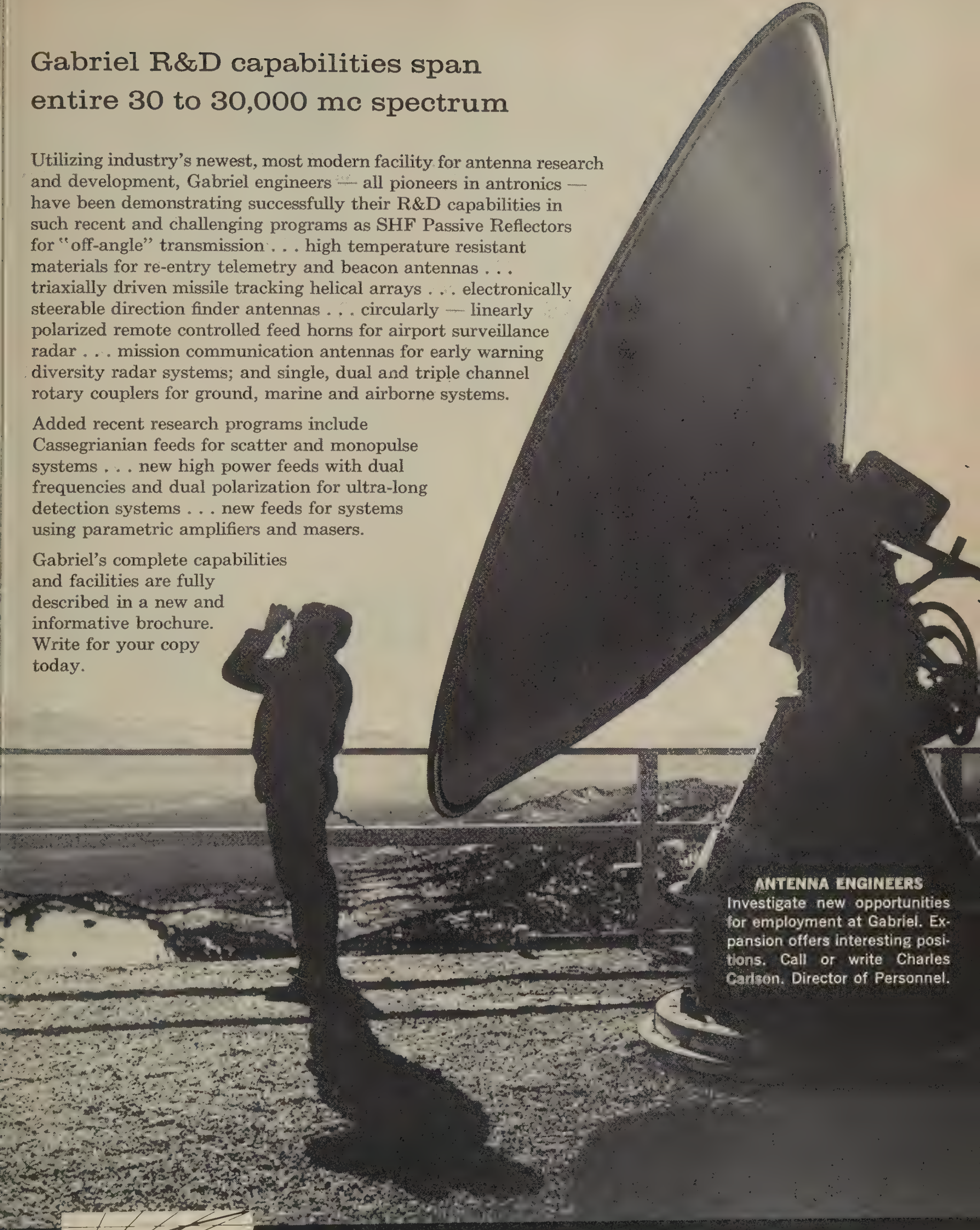
Standard Red Line connectors an adaptors are available for immediat delivery.

Circle Reader Service Card 121

(*Continued on page 91*)

Circle Reader Service Card 52

Gabriel R&D capabilities span entire 30 to 30,000 mc spectrum



Utilizing industry's newest, most modern facility for antenna research and development, Gabriel engineers — all pioneers in antronics — have been demonstrating successfully their R&D capabilities in such recent and challenging programs as SHF Passive Reflectors for "off-angle" transmission . . . high temperature resistant materials for re-entry telemetry and beacon antennas . . . triaxially driven missile tracking helical arrays . . . electronically steerable direction finder antennas . . . circularly — linearly polarized remote controlled feed horns for airport surveillance radar . . . mission communication antennas for early warning diversity radar systems; and single, dual and triple channel rotary couplers for ground, marine and airborne systems.

Added recent research programs include Cassegrianian feeds for scatter and monopulse systems . . . new high power feeds with dual frequencies and dual polarization for ultra-long detection systems . . . new feeds for systems using parametric amplifiers and masers.

Gabriel's complete capabilities and facilities are fully described in a new and informative brochure. Write for your copy today.

ANTENNA ENGINEERS
Investigate new opportunities for employment at Gabriel. Expansion offers interesting positions. Call or write Charles Carlson. Director of Personnel.

Gabriel electronics DIVISION OF THE GABRIEL CO., MILLIS, MASS.

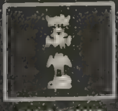
PIONEERS IN ANTRONICS

AIRPORT SURVEILLANCE RADAR ANTENNAS

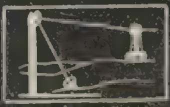
ROTARY JOINTS

POINT-TO-POINT COMMUNICATION ANTENNAS

FEEDS AND HORNS



DRONE & DRONE CONTROL ANTENNAS



RESEARCH & DEVELOPMENT

one good turn

gets another at *LEVINTHAL*

High-power pulse transformers, chokes, power transformers, and related magnetic components roll out of the Levinthal transformer department in a daily stream.

The advanced and expanding facility for producing these specialized high-quality devices is limited physically only by the present bake-out oven which is 4½ by 9 by 6 feet. As far as we can discover, there is *no* limitation on the engineering skills of the staff.

They are prepared to undertake projects in the following general categories: Pulse transformers to 600 kv with average powers of several-hundred kva, peak powers to 100 megawatts, and pulse lengths to 500 μsec; Power transformers separately or in assemblies to commercial or MIL specifications over the range 10 to 55 kv d-c and 1 to 400 kva; Filter reactors in commensurate ranges; and High-voltage low-capacitance and/or high-reactance dry-type isolation transformers from 10 to 55 kv and with outputs from 100 v-a to 6 kva.

PULSE-TRANSFORMER ASSEMBLY
Above, complex pulse package for beam-type tube, to MIL-T-27A specification. Comprises main pulse transformer, low-capacitance filament transformer, filament-current transformer, beam peak-current transformer, secondary capacitance divider, tube socket, and focus-coil mount. Ratings: 132 kv at 98 amp peak; 11 μsec at 191 pps; 3.25 μsec at 381 pps.

RECTIFIER PLATE TRANSFORMER
Center, suitable for use with various rectifiers, unit supplies 45-kv d-c, with reversible polarity, at 0.15 amp. Includes: 3-phase delta to wye rectifier transformer and 6 rectifier filament transformers.

COMPACT CHARGING REACTOR
Far left, concentrating three times the power capability of the commercial unit, behind it, into a 17-in. cube, this MIL-spec choke has Class H construction and finned case for 180 C operation. Ratings: 3.45 hy, 22.5 kv peak, 3.40 amp, 190 pps.

MISCELLANY
Other units shown include 40- and 50-kv low-capacitance filament or isolation transformers from a standard line and miscellaneous low-voltage filter chokes.

Circle Reader Service Card 53

ANSMITTERS, MODULATORS, AND POWER SUPPLIES FOR COMMUNICATION, RADAR, AND TUBE DEVELOPMEN

LEVINTHAL ELECTRONIC PRODUCTS
STANFORD INDUSTRIAL PARK · PALO ALTO 7, CALIFORNIA

SUBSIDIARY OF
RADIATION
INCORPORATED

Visit Wescon this yea
at the Los Angeles
Sports Arena and
see us in booth No. 82

EITEL-McCULLOUGH, INC.

SAN CARLOS • CALIFORNIA

The history of Eitel-McCullough, Inc., world leader in transmitting tube industry, is one of steady growth ing the past quarter of a century. Founded in San uno, California, in 1934 by W. W. Eitel and J. A. Mc- lough, the new business began with capital of $5,000.

From the humble beginning, the company expanded dily from the initial Eimac Product, a triode which s manufactured for amateur radio operators. Other tubes e added to the Eimac line and the number of personnel eased. In 1939 the first Navy sea radar tests used ac tubes.

This vacuum tube specification has established the com- y as a leader in its field and has made Eitel-McCullough, one of the world's largest manufacturers of transmit- g tubes.

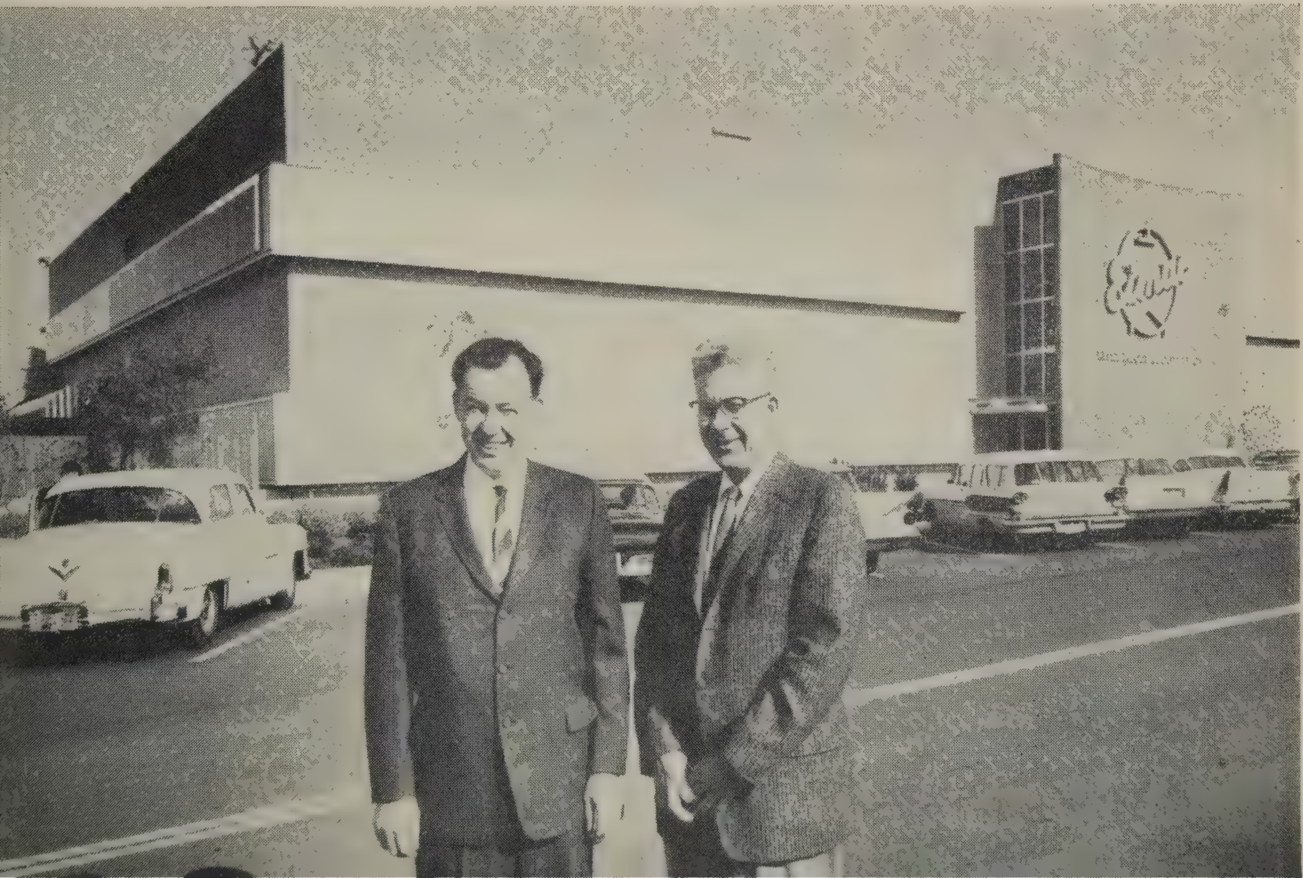
The company's first tube, the 150 T, a triode, introduced a new word to the electronic industry. That word was "Eimac," a name now well-known throughout the world.

Company Growth

The company's early growth was a slow, steady expansion paced by the demand for the quality electron tubes which the company developed. As the product line expanded, the company outgrew its original shop in San Bruno — a small store — and moved to larger quarters. The original staff of three increased to twelve by 1937 and to seventeen by 1939.

World War II produced an almost over-night mushrooming expansion as Eimac geared to meet the enor-

W. Eitel (left), president, and J. A. McCullough, executive vice president, co-founders of Eimac in 1934, are shown in front new 150,000 square foot manufacturing plant and corporate headquarters in San Carlos, California.



mous military demands for power electron tubes. In 1940, the company received its first big order from Western Electric calling for the delivery of 10,000 tubes. This order put Eimac on a mass production basis. Production increased during World War II to a peak of well over 100,000 tubes per month. By 1941 Eimac was working three shifts, and in 1942 the company built a second plant at Salt Lake City. The company's performance during the war led to the presentation of the Army-Navy E award and Army-Navy Public Service Award for Eitel and McCullough.

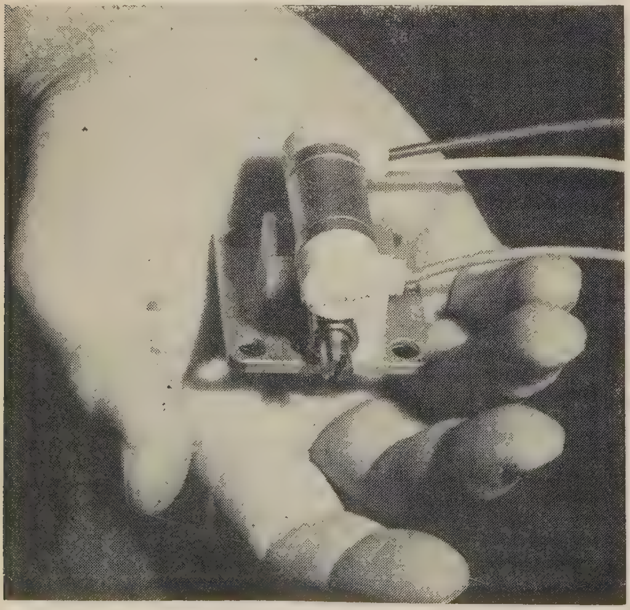
With the end of World War II, the military market for electron tubes dwindled. Eimac, faced with competition in the form of its own tubes being sold at less than cost on the surplus market, created a new line of superior tube types. This resulted in a second period of growth for Eitel-McCullough, Inc.

Through expanded research and development, new and improved tubes have been introduced to industry . . . until today the Eimac line includes more than 100 different tube types and hundreds of associated products. Even the Salt Lake City plant, during the peak of the TV boom, produced television picture tubes. This operation was discontinued when the high demand for TV tubes declined. However, the program resulted in the sale of hundreds of thousands of picture tubes of various sizes and types.

Facilities

During 1958 a new $2 million Eimac facility was completed at San Carlos, California. This construction supplements the San Bruno and Salt Lake City plants with approximately 145,000 square feet of production space and 30,000 square feet which now accommodate the company's headquarters and administrative offices. This new plant, one of the most modern electron tube facilities in the country, has all production areas designed on a "flow" system for maximum efficiency. Several near-sterile "clean rooms," pressurized with filtered, conditioned air and protected by double-door air locks, are used for critical assembly work to assure maximum tube yield and reliability.

Within the past year Eimac has adapted ceramic to reflex klystrons. The klystron shown here operates in the 11 kmc region.



Four giant Eimac-developed rotary vacuum pumps, capa of producing high vacuum in thousands of tubes per are now in operation at San Carlos.

A fourth facility, leased in 1959, is located at Belm California and houses the major portion of Eimac's search and Development activity. From a staff of th in 1934, the company has expanded to more than 2, people today in four modern facilities for manufacturi development and research. But the fast pace of grov continues unchecked!

Additional plant expansions totaling $1,350,000 83,000 square feet are now underway. Scheduled for co pletion this year are two new buildings at San Car one plant for the newly-formed Parts Division and other for super power tube development and producti The added construction will give the company a quart million square feet in that city.

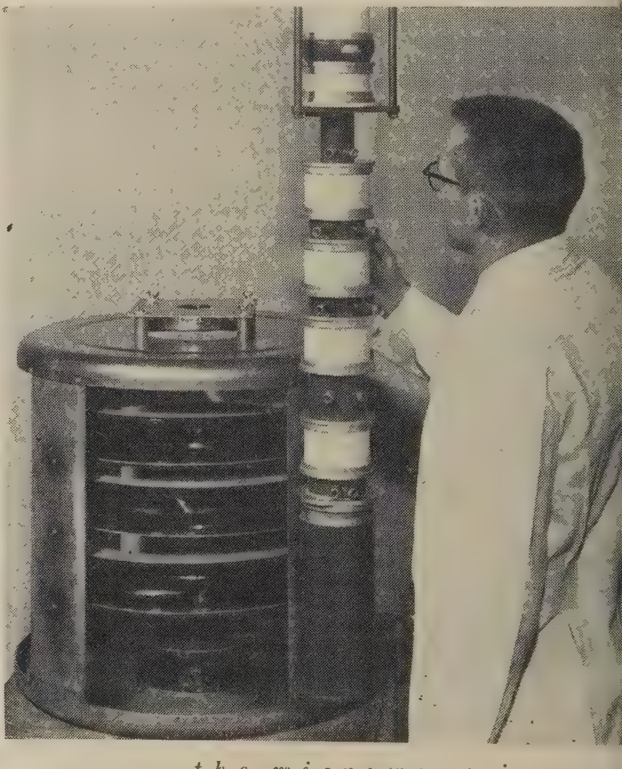
The enlargement includes 23,000 square feet space to be used for expanding National Electroni Inc., of Geneva, Illinois, the largest manufacturer of dustrial control tubes in the United States. This compa a wholly-owned subsidiary of Eitel-McCullough, Inc., acquired in December, 1959, and put Eimac into thyratron, ignitron, and rectifier tube field.

Products

The company's 26 year history has been one of notal achievement. In its early years, for example, Eimac veloped tubes for the first FM broadcasting transmitter operate successfully at the maximum allowable power 50,000 watts.

Eimac-developed tubes were used in the first Navy s radar test in 1939 and extensively in communications a radar equipment during World War II. Today, Eim klystrons are used in nearly every major troposcatter sy tem, such as Dew Line, Pole Vault, White Alice, Tex

Eimac's external-cavity amplifier klystron design is shown this 4 km 50,000 lq klystron.



ers, NATO's Ace High project, and many others.
ac klystrons also power the world's first transoceanic
-the-horizon television link between Florida and Cuba.
er Eimac tubes have been instrumental in tracking
controlling space satellites, and missiles. A super-
er tube, an amplifier klystron used to power a giant
r ballistic missile tracker, was recently developed and
anufactured by Eimac. This giant klystron, known as
X626, which will deliver 1,250,000 watts of peak
e power and 75,000 watts of average output power,
used in the Venus radar contact.

imac currently manufactures over 100 commercial
types and hundreds of accessory items. In addition,
ens of "X-number" or developmental tubes are manu-
ured to customer specifications on special contracts.
product line is well diversified. Diodes, triodes, tet-
es, and pentodes were Eimac's original stock-in-trade
still constitute over one-half of the product line.
se types include both internal and external anode tubes
oth glass and ceramic-metal construction and numer-
specialized types such as planar triodes, radial-beam
odes and pulse modulators.

nother large portion of the Eimac product line is made
of Eimac-developed power amplifier klystrons. This
gn incorporates ceramic-metal construction for me-
iical ruggedness and improved performance at UHF.
ac has also developed and is now manufacturing ad-
ced reflex klystrons, traveling-wave tubes, and voltage-
eable magnetrons. These devices incorporate Eimac-
eloped ceramic-metal design for applications where
re environmental conditions are anticipated.

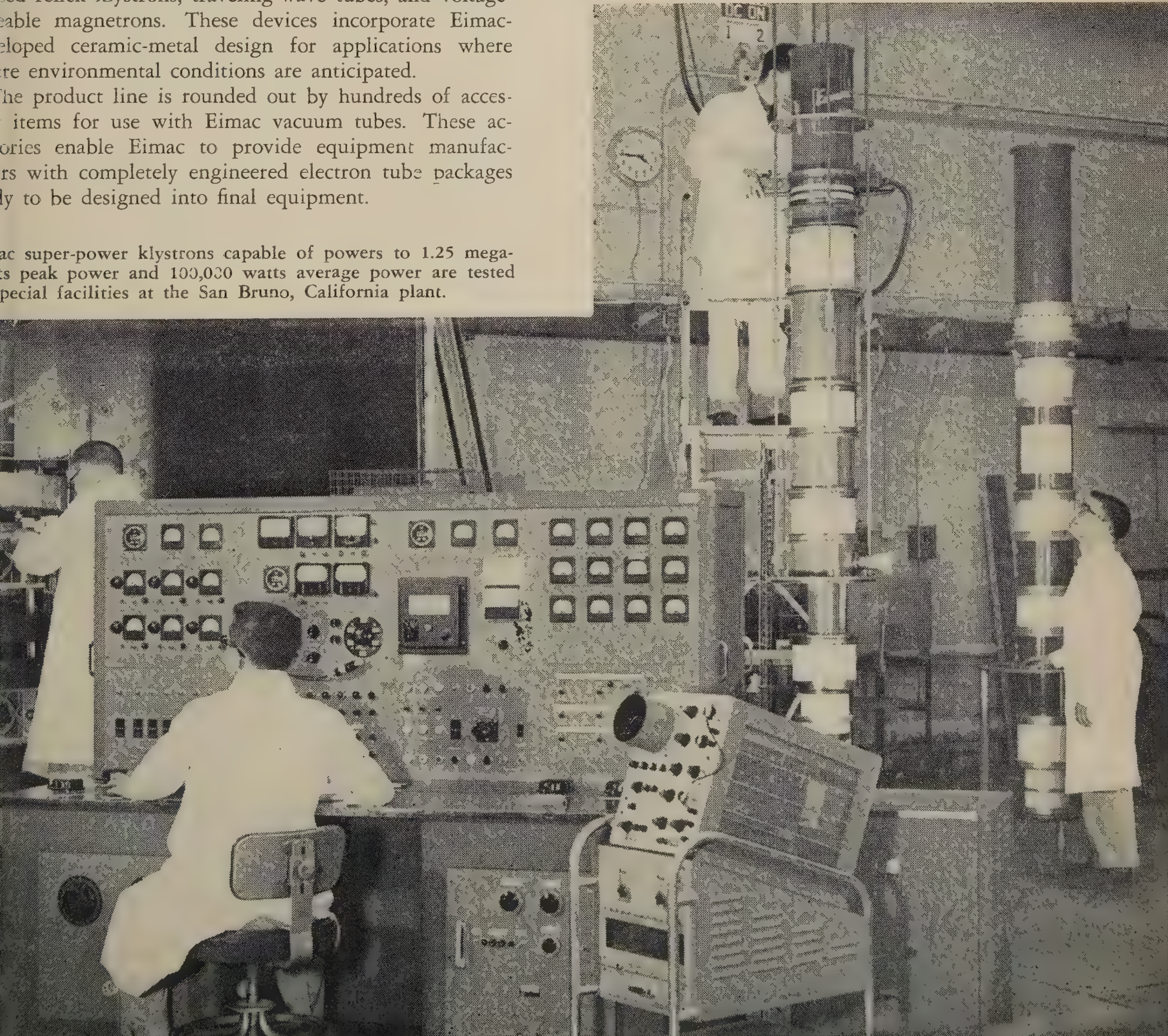
he product line is rounded out by hundreds of acces-
items for use with Eimac vacuum tubes. These ac-
ories enable Eimac to provide equipment manufac-
rs with completely engineered electron tube packages
ly to be designed into final equipment.

Research and Development

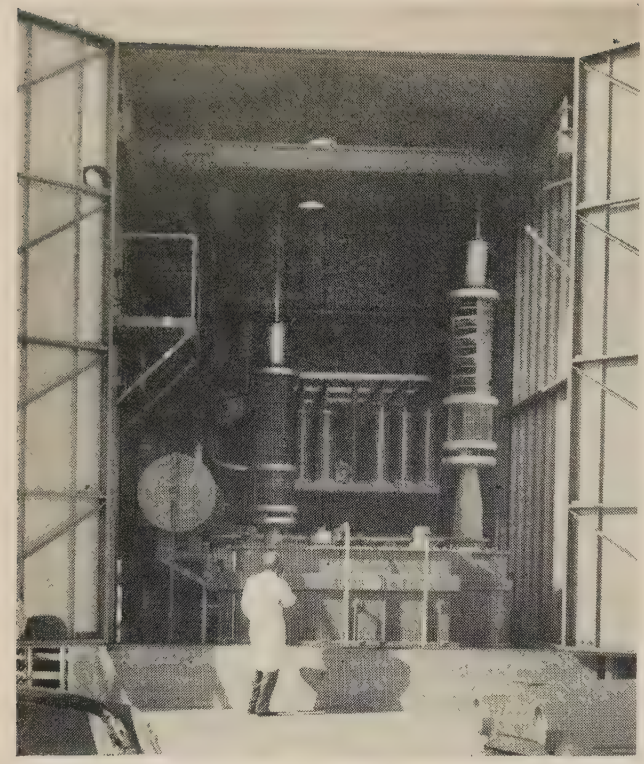
Eimac's widely diversified and well-rounded product line has been the result of consistent interest in research and development. The company instituted and organized a program of research and development in 1942 and set up a special division of the company to carry out this work. The success of this program is borne out by the fact that more than 50 per cent of Eimac's total sales today are attributed to tubes introduced since 1950.

At present, approximately 250 people are engaged in full time research and engineering work. Of this number, more than half are skilled professional scientists and engineers, including specialists in electronics, physics, chemistry, mechanical engineering and metallurgy. Modern facilities for carrying on research in all of these fields are available. In many cases, Eimac develops its own laboratory equipment to fill unusual needs in vacuum tube research. An excellent case in point is the new high voltage dc power supply and laboratory used in the development and production of a new line of super-power klystrons. This power supply, developing 240,000 volts dc at two amperes, is one of the largest in the United States. Extensive environmental test equipment is available for checking the performance of Eimac tubes under unusual conditions of shock, vibration, humidity, and high altitude.

Specific research work is done in development groups



ac super-power klystrons capable of powers to 1.25 mega-
ts peak power and 100,000 watts average power are tested
pecial facilities at the San Bruno, California plant.



This 240,000 volt DC power supply can achieve a current of 2 amperes at maximum voltage.

which are made up of teams of scientists and technicians specializing in particular types of electron devices and processes. These groups handle both company-sponsored and customer-sponsored projects.

Eimac's microwave tube unit, expanded for researching and production of reflex klystrons and other microwave devices, has recently been transferred from the company's Salt Lake City plant to its San Carlos plant.

Much research and development activity at Eimac is directed toward producing specific marketable products within the shortest possible time. The longer-range goals of investigating entirely new concepts of vacuum tube design, production, and theory are carried on by the Advanced Research Group. The company has already applied many of the developments made by this group to actual production tube types.

The results of research and development work at Eimac have been both numerous and rewarding. This work has been responsible for the company's present line of power amplifier klystrons which cover a broad range of power and frequency levels. Ceramic negative grid tubes are also products of recent years' developments.

Efforts to improve tube ruggedness, compactness, and performance led Eimac to institute a research and development program directed toward applying new materials and techniques to the manufacture of vacuum tubes. Perfection of the quartz-to-metal sealing technique for windows of high-frequency tubes and the utilization of beryllium oxide as an envelope material are typical of Eimac's latest "firsts."

The result of the R & D program has been a highly successful series of tube types that are made entirely of ceramic and metal, completely eliminating conventional glass construction techniques. The success of this program is borne out by the fact that over one-third of the Eimac line now consists of ceramic-metal types that are wid used in critical military and commercial applications.

Well integrated research and development activit have placed the company in an excellent patent positi Eimac now owns more than 200 U.S. patents and o 150 foreign patents in 10 countries. In addition, patents are pending in the U.S., with 153 pending abro and over 20 additional applications in the process of fili A number of tube manufacturers enjoy the advantages these patents under licensing agreements with Eit McCullough, Inc.

Even though the company is primarily a manufactu of vacuum tubes, Eimac has developed prototype equi ment utilizing new tube types when necessary in solvi unusual application problems.

Markets

Eimac products are marketed throughout the Unit States and its possessions and in 58 foreign countries. T company's Marketing Division in San Carlos, Californ controls and coordinates the activities of numerous d mestic representative and regional sales offices and 25 ov seas representatives. This division pursues an active pr gram of market research to evaluate the electronics mark and the company's position in them. This important re search is used in planning future activities of the company in choosing markets to be entered, and in maintaining well-balanced product line.

The Eimac environmental test laboratory has a wide variet of equipment for testing electron devices under varying co ditions of shock, vibration, acceleration, temperature, humidit and altitude.

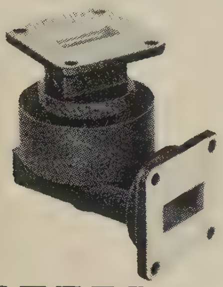
Early this year, Eimac announced the establishment o Eitel-McCullough, S.A., a wholly-owned marketing sub sidiary in Geneva, Switzerland.

Total 1959 sales exceeding $29 million — a 60 pe cent jump over the highest preceding year — reflect th scope of the growth of Eimac.

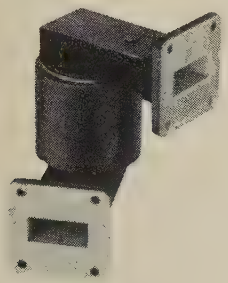
(*Continued on page 90*)

ou'll save engineering time
n ROTARY JOINTS
ith MDL's stock designs . . .

I -STYLE



L -STYLE



U -STYLE

And they're fully tested, with electrical per-
ance certified in writing!

hy spend time engineering your own rotary
s when MDL has done it for you. Chances
the rotary joint for precisely your require-
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available on short notice in the material and
n you require.

very MDL rotary joint undergoes extensive
rical tests before shipment, to assure per-
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er testing. And MDL guarantees every joint
written proof of electrical performance.

or rotary-joint applications entailing special
rical or mechanical requirements, MDL has
engineering, prototyping, and production ca-
lities to meet any specification — including
plex dual and triple channel configurations.
's twelve years of leadership in developing
sion waveguide components means unex-
d experience to help you solve any rotary-
problem.

or a copy of our new rotary-joint catalog, or a
npt quotation on either stock design or spe-
rotary joints, write us today.

MDL STOCK-DESIGN ROTARY JOINTS

Available either non-pressurized or pressurized to 30 psig, except where indicated by * (*non-pressurized only)

EIA WR ( ) Waveguide Size	Frequency (kmc)	VSWR	WOW	Insertion Loss (db)	Peak Power at Atmospheric Pressure (kw)	MDL Type Number
"I" JOINTS						
90	8.5 – 9.6	1.10	1.02	0.10	150	90RJ116
112	8.5 – 9.6	1.10	1.02	0.10	150	112RJ116
"L" JOINTS						
90	8.5 – 9.6	1.10	1.02	0.10	150	90RL116
90	8.5 –10.0	1.20	1.04	0.15	100	90RL126
112	8.5 – 9.6	1.10	1.02	0.10	150	112RL116
187	5.4 – 5.9	1.10	1.02	0.10	200	187RL16
"U" JOINTS						
90	8.5 – 9.6	1.15	1.02	0.10	200	90RU116
90	8.5 – 9.6	1.10	1.02	0.10	150	90RU126
90	8.5 – 9.6	1.15	1.02	0.10	10	90RU136*
112	8.0 –10.0	1.20	1.03	0.20	20	112RU16*
112	7.5 – 8.5	1.15	1.03	0.20	20	112RU26*
112	8.5 – 9.6	1.12	1.03	0.20	180	112RU36
112	8.5 – 9.6	1.10	1.02	0.10	250	112RU116
112	8.4 –10.0	1.20	1.04	0.15	250	112RU126
112	8.5 – 9.6	1.15	1.03	0.10	10	112RU136*
112	7.0 –10.0	1.50	1.04	0.20	10	112RU146*
137	5.4 – 5.9	1.20	1.02	0.20	10	137RU116*
187	4.25–6.00	1.50	1.03	0.30	10	187RU116*
187	5.40–5.90	1.10	1.02	0.10	500	187RU126
187	5.25–5.75	1.10	1.02	0.10	500	187RU136

MDL

Microwave Development Laboratories, Incorporated
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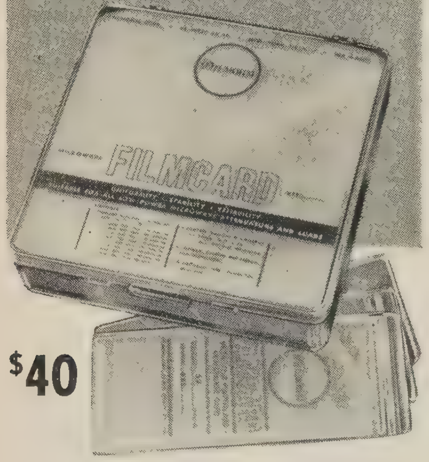
special introductory offer!

NEW LABOR-SAVING, MONEY-SAVING FILMOHM

FILMCARD

KIT FOR MICROWAVE APPLICATIONS



$40

Here in one compact, low-cost Kit is a practical assortment of precision-made, high stability microwave resistance material in easy-to-use form. Recommended for all applications requiring accurate and reproducible dissipation at low R. F. power, FILMOHM Resistance Cards may be punched, drilled, sheared, machined or sanded to suit your needs. Ideal for use as microwave attenuators and terminations, FILMCARDS are also THE proven material for directional coupler loads, isolation and impedance matching, protection of crystals and mode suppressors.

HERE'S WHAT YOU GET —

11 metal film Resistance Cards, 2½″ x 5⅝″ and one metallized mica Resistance Card, 2″ x 2½″; plus fabrication instructions and technical bulletins.

FILMCARD FEATURES —

- MEETS MIL-P-18177 SPECIFICATIONS
- RESISTANCE RANGE AVAILABLE: 25 to 750 ohms/sq.
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- RESISTANCE TOLERANCE PER SQ.: ± 10% standard.
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Eitel-McCullough

(*Continued from page 88*)

People

Backing Eimac's technological progress is an administrative force of r who are leaders in their respective fields.

W. W. Eitel and J. A. McCullough, co-founders of Eimac, are ard amateur radio enthusiasts. In fact, it was this interest that spurred their er into the electron-tube business. They are both fellows in the Institute Radio Engineers.

Gould Hunter, executive vice president, is a former Navy captain a Annapolis graduate. Immediately prior to his Navy retirement he was co manding officer of the Navy Electronics Laboratories at San Diego. Rich T. Orth, vice president, Planning, was formerly vice president and gen manager of the tube divisions of R.C.A. and Westinghouse.

Mr. E. E. McClaran, with Eimac since 1951, heads up Finance as a v president, and John H. Hutchings holds the position as president of N tional Electronics, Inc.

The company's divisional research and engineering operations are spe headed by such men as Director of Research Dr. Donald A. Dunn, who is a a research associate on the faculty of Stanford University; Associate Resea Directors Dr. Oskar Heil, discoverer of the principle of velocity modulati and Donald Preist, widely known for his achievements in microwave tu development; and Development and Engineering Director Earl J. Shelt formerly manager of Raytheon's High Power Tube Lab.

Eye on the Future

Growth and development at Eimac continues at a fast pace. And inves interest in Eimac remains firm. The company's stock was offered to public for the first time in 1954. Approximately 10 per cent of the sha holders are employees.

With a dynamic management — and co-founders Eitel and McCullough provide leadership into the challenging decade just opening up — Eimac geared to continue its steady growth . . . setting the pace for progress in t industry it helped to pioneer — electronics.

In the field of microwave engineering, Wheeler Laboratories occupies a unique position as an industrial laboratory devoted exclusively to consulting and development.

As a service to many prominent laboratories and manufacturers, WL designs radar and communication antennas, waveguide components, and microwave assemblies. Your inquiries are invited.

WHEELER LABORATORIES, INC

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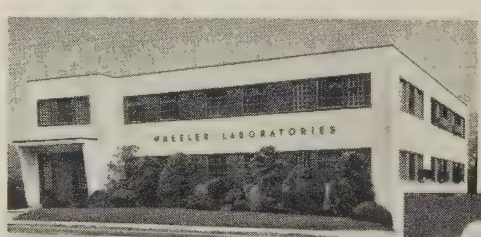
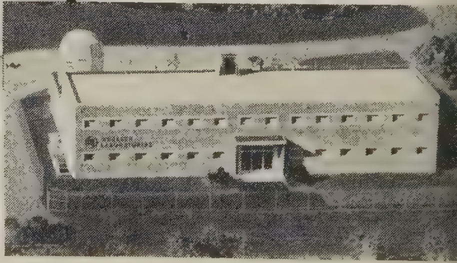


◄ Main Office and Microwave Laboratory
Great Neck, New York

▼ Antenna Laboratory and Test Range
Smithtown, New York



WL
HAROLD A. WHEELER
and Engineering Staff

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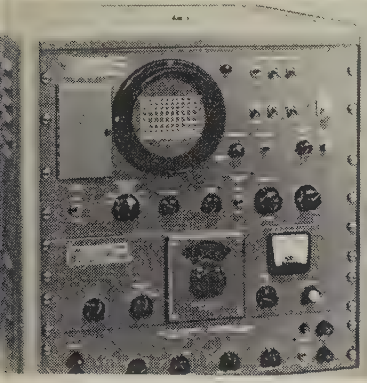
(*Continued from page 82*)

FASTER SSB ANALYSIS OF RANSMITTERS AND RECEIVERS EATURED BY NEW SPECTRUM ANALYZER

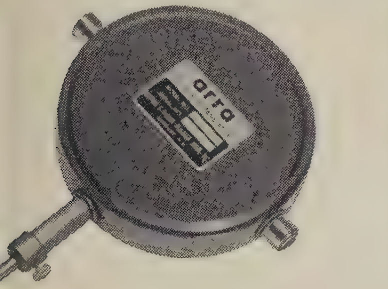


Motorized tuning, increased frequency ge (100 cps-40 mc), and a more ver- ile two-tone audio generator are three the new design features in Panoramic's v model SSB-3a Single Sideband Spec- m Analyzer that speeds a wider vari- of SSB and AM transmitter and re- ver tests.

Five preset modes of operation (with eset sweep rate, gain and optimized olution at preset sweep widths of). 500, 2000, 10,000 and 30,000 cps), well as continuously adjustable set- gs of each, full 60 db dynamic range

(*Continued on page 92*)

arra π LINE CONTINUOUSLY VARIABLE ATTENUATOR



clusive Features:

- Broadband Impedance Match.
- Min. VSWR for all values of attenuation over band.
- Insertion Loss: 0.2 db max.
- Drive: Shaft drives for systems & power level applications.
- Connectors: Type "N" Female (others on request).
- Size: 5" dia. x 1" high, excluding connectors and micrometer.
- Power Rating: 10 watts average min.
- Continuously variable for all values of attenuation.

Write for Information — Dept. P-IRE

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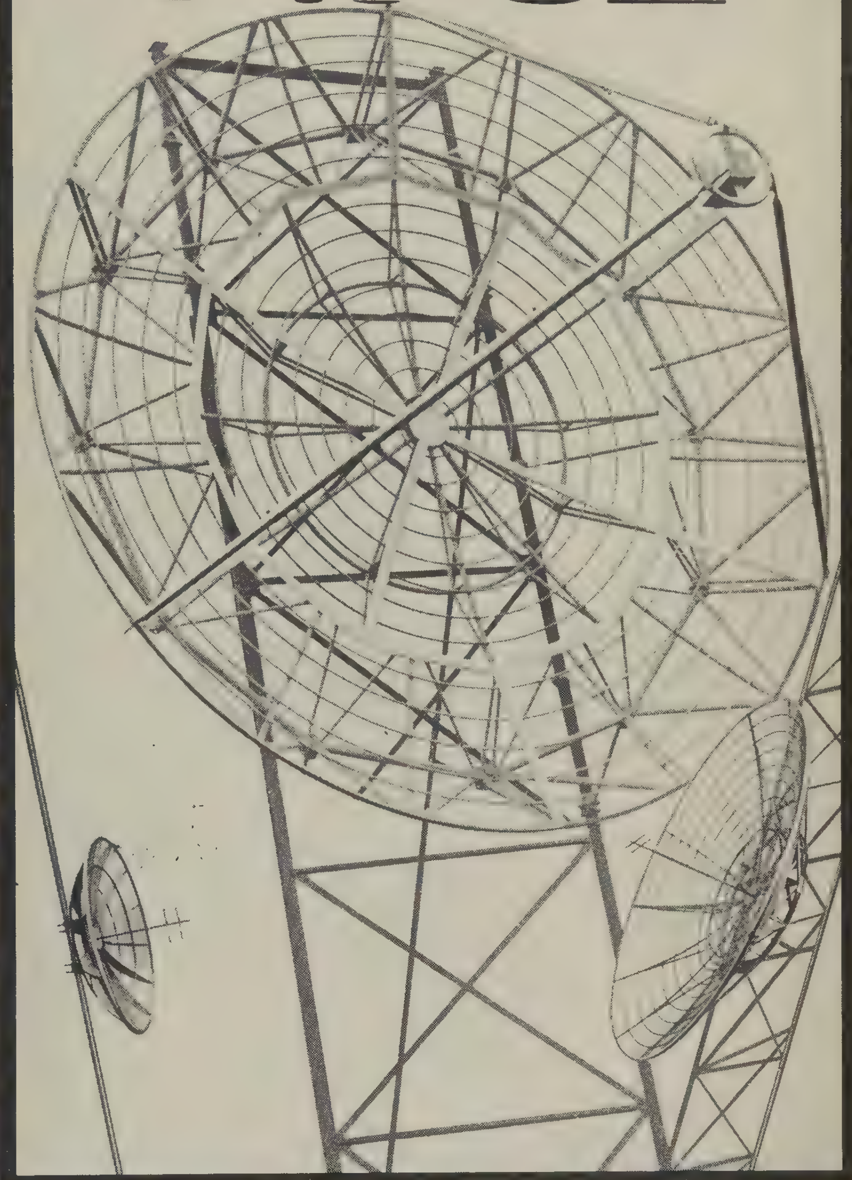
4′ to 32′



PARABOLIC ANTENNAS

TACO DEVELOPMENTAL FACILITIES
Taco owns and operates one of the most advanced antenna laboratories in the world. Free-space test sites, completely equipped with the latest instrumentation are currently probing the frontiers of advanced antenna designs . . .

A standard line of parabolic reflectors designed to provide high electrical and mechanical efficiency, simple installation, and a high degree of mounting and driving versatility. Also, Taco offers a standard line of drivers for single, dual, and circular polarization, as well as design services for development of custom drivers for beyond-the-usual requirements.

See us at WESCON Booth #740

WRITE FOR COMPLETE TACO CATALOG ON PARABOLICS, HELICALS, RUGGEDIZED YAGIS, AIRBORNE AND OTHER ANTENNA DESIGNS . . .

TACO
SHERBURNE, NEW YORK

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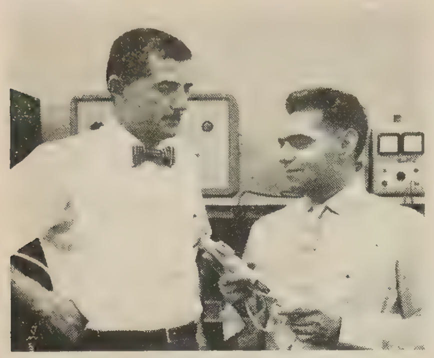
SOLID STATE FRONTIERS



Motorola Solid State Devices Laboratory Manager Cacheris and Developer Sakiotis with XS01 Switch.

NEW FERRITE SWITCH OFFERS FIRST BROADBAND MICROSECOND SWITCHING

Microwave systems engineers looking for a fast-acting, highly reliable duplexing device will do well to investigate the advantages of the Model XS01 Ferrite Switch.

Operating at X-band, the 3-port device provides an 18% bandwidth and can be switched in less than one-millionth of a second. Moreover, it has high average power handling capability and, to our knowledge, is the only one of its kind.

Supplementing a circulator with a switch of this kind eliminates the need for T-R tubes in the majority of applications and, thus, shortens switching time, prolongs operating life and improves reliability. The XS01 has a wider bandwidth than differential phase shift circulators and has the added advantage of much smaller magnetic field requirements, and, consequently, smaller driver units.

The switch is also available in a 4-port version for receiver-transmitter switching between two antennas.

TYPICAL SPECIFICATIONS

Frequency range	8.75-10.5 kmc
Insertion loss	1.25 max.
Isolation	23 db min.
Input VSWR	1.4 max.
Power handling capability	80 watts avg.
Minimum switching time	0.75 usec.

REPRESENTATIVE MOTOROLA SOLID STATE DEVICES

ISOLATORS • CIRCULATORS • PARAMETRIC AMPLIFIERS • SWITCHING CIRCULATORS • HIGH-SPEED, BROAD-BAND SWITCHES • PHASE SHIFTERS •

For detailed information, write:

MOTOROLA INC.
Solid State Electronics Department
8201 East McDowell Rd.,
Scottsdale, Arizona WHitney 5-6311

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New Products

(*Continued from page 91*)

and exceptional selectivity are among the unique features of the earlier model SSB-3 retained in the improved version.

The motorized tuning frequency control (retro-fit to model SSB-3) permits quicker coverage of the entire frequency range. The 100 cps-2 mc band is added by the optional model REC-1 Range Extending Converter.

The new model TTG-2 two-tone audio generator provides single or dual tones, independently adjustable in frequency from 100 cps to 10 kc (± 1 per cent accuracy), from two to four volts (metered) into matched 600 ohm loads. IM, harmonics and other spurious are less than — 60 db.

Full information and specifications available from Panoramic Radio Products, Inc., Mount Vernon, N.Y. Single Sideband Spectra are discussed in Vol. 1, No. 3 of the Panoramic Analyzer, published by the company.

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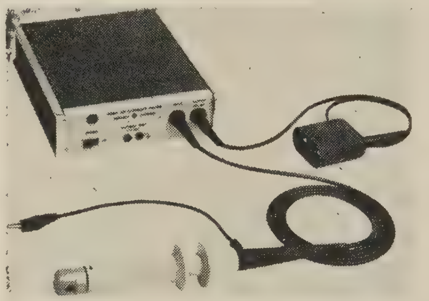
—*mwj*—

NEW AC CURRENT PROBE SIMPLIFIES CURRENT MEASUREMENTS



A unique instrument which converts ac current to ac voltage for direct reading on a conventional oscilloscope or ac voltmeter is now available from Hewlett-Packard Co., Palo Alto, Cal.

The instrument, model 456A AC Current Probe, has a probe which clamps around the current-carrying wire, providing a voltage output which is quickly and easily read on a VTVM or oscilloscope. The instrument's 1 mv to 1 ma unity conversion permits direct readings in milliamperes on voltmeters or oscilloscopes.

The model 456A measures current without direct connection to the test circuit and with no appreciable circuit loading. Typical applications include measurements on transistors, vacuum tubes and logic circuits.

The instrument's wide bandwidth (20 cps to 15 mc) also permits oscilloscope viewing of complex current waveforms with rise times as fast as 0.08 microseconds. The model 456A simplifies ac current measurements of up to one ampere at frequencies up to 5 mc and at least 100 ma from 5 mc to 15 mc.

Model 456A is a compact unit weighing only 3 pounds. It is priced at $190.00 and its current availability is 14 weeks.

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Circle Reader Service Card 60 ▶

NEW REDESIGNED AND EXPANDED LINE OF MINIATURE OSCILLATOR CAVITIES

from 800-7000mc by
TRAK ELECTRONICS COMPANY

From its twelve years of research, development and experience with microwave oscillator cavities, TRAK now announces two new standard cavities:

(1) TRAK Type 9127-C for C-Band Pulse Service, 5400-5900 mc, pictured above.

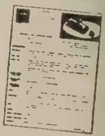
(2) TRAK Type 9127-S for S-Band Plate or Grid Pulse Service and as a CW oscillator, operating in any 300mc part of 2700-3600mc.

Other cavities engineered to customer specifications, 800-7000mc.

TRAK cavity Type 9127-C is shown above and its specifications are:

Frequency	Tunable from 5400—5900mc. Tuning done by adjusting a screw located on one end of the cavity.
Tube Type	G. E. 7486.
Power Out	Greater than 50W peak minimum over the band. (0.002 duty cycle, 1 microsecond pulse, 1000 volt pulse at approx. 0.7 amps. Higher powers obtained by using higher pulse voltages.) Depending upon the individual tube, output powers exceeding 100W peak have been obtained.
Output Pulse Rise Time	Less than 25 millimicroseconds.
Leading Edge Jitter	Approx. 5 millimicroseconds.
Temperature Stability	±0.05% from 0°C. to +71°C.
Shock	100G for 7 milliseconds in each of 3 major axes results in less than max. ±0.25mc. FM.
Vibration	15G from 50 to 2000cps. in each of 3 major axes results in max. ±1mc FM. Cavity survived 56G at 2000 cycles with less than ±4 mc FM.
Size	1″ diameter x 2½″ long, excluding output connector and mounting brackets.
Weight	4 ounces.
Output Impedance 50 ohms.	
Output Connector	Type TNC.
Mounting	Engineered to customer specifications.

We invite you to write for TRAK Cavity Technical Bulletins.



TRAK ELECTRONICS

MICROWAVE COMPONENTS DEPT.
TRAK ELECTRONICS CO.
Division of CGS Laboratories, Inc.
55 Danbury Road, Wilton, Conn.
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SANDERS ASSOCIATES

BOOTHS 929-930

ew modular Tri-Plate® semiconduc- mounts extend the breadboarding ver- ity in strip transmission line circuits Sanders' Tri-Plate Modules. For the time microwave and computer en-

eers can incorporate the new semicon- tor devices directly into their cir- s using standard Tri-Plate module ilding blocks." These new modules available for cartridge, double ended, , or pigtailed glass packages.

ther new Tri-Plate Modules featured he Sanders Associates booth numbers -930 in the 1960 Wescon show will ude phase shifters, delay lines, and iable couplers. Sanders is also in- ducing a standard 50 ohm and special v impedance 10 ohm Tri-Plate slotted es with module connectors.

New cost reduction advantage devel- ments in semiautomatic wiring of as- mblies and sub-assemblies will be dis- yed by Sanders Flexprint Products Di- ion. Flexprint® wiring permits great- circuit reliability by reducing reject te, conforms to better packaging de- gn and simplifies complex circuit as- mbly thus lowering production costs.

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—*mwj*—

GENERAL RADIO

Booths 957-958

A number of new developments in instru- ents and methods of measurement will be atured by the General Radio Co., West oncord, Mass., in its booths (957-958) at escon 1960.

To be shown for the first time will be a w version of the stroboscopic tachome- r, sold for many years under the trade me Strobotac®, and widely used in the echanical and electrical industries for easuring the speed of rotating machine rts and for observing their operation slow motion.

Included in the operational display will a rapid, production setup for an imped- ce comparator (Type 1605-A) for the easurement of small semiconductor capaci-

(*Continued on page 94*)

...for the greatest variety of types and sizes it's TRANSCO

No matter what your microwave switch needs, TRANSCO is qualified to fill all your coaxial and waveguide switch requirements. Since 1947, specialists in reliable switches with better R.F. performance characteristics.

NEED HELP NOW? Application Engineers and Representatives throughout the U.S. and Canada...or send for complete microwave switch data file.

CREATIVE MICROWAVE ENGINEERS...write for information about YOUR future with this progressive, well-established firm.

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COAXIAL SWITCHES
WAVEGUIDE SWITCHES
ANTENNAS
MICROWAVE COMPONENTS
VALVES
ACTUATORS

Circle Reader Service Card 61

(Continued from page 93)

tances of the order of 1 or 2 pf. Also featured will be a transfer-function and immittance bridge (Type 1607-A) measuring the R, L and C parameters of tunnel diodes at ultrahigh frequencies.

Another test arrangement will include a beat-frequency video generator (Type 1300-A) for sweep measurements showing the characteristics of if-amplifier strips on an oscilloscope.

Still another operating display will show an impedance bridge (Type 1650-A) with test jig for the rapid testing of components.

The exhibit will also include instruments for automatically recording the frequency-response of acoustical and audio-frequency devices with random-noise excitation.

Among other products on display will be Variac® auto-transformers and automatic line-voltage regulators.

Circle Reader Service Card 151

— *mwj* —

MELABS, INC.
Booth 2224

A series of electronically tuned, swept signal generators and a broad tuning range radiometer-receiver are among the new electronic instruments and components to be introduced by Melabs, Inc., Palo Alto, Cal., at the 1960 Wesco Show.

Melabs, formerly known as Microwav Engineering Laboratories, Inc., will e hibit several new instruments and con ponents at the show. These will be di played at Booth 2224.

Among the new equipment to be in troduced by the company are:

Swept Signal Generators, a series o electronically tuned generators which in cludes five units covering, respectivel the L, S, C, X and K band frequencie (1 to 18 kmc). A common power an sweep supply (Model SGO-2) can b used with any of the units. All fiv generators are compatible with Melab radiometer and panoramic display uni and the addition of a receiver box create a swept receiver or signal frequenc analyzer.

Radiometer-Receiver, Model RSU-X which covers any frequency from 1000 t 12,000 megacycles. With a sensitivity t — 120 dbm, the instrument is extremel useful as an ultra-sensitive lab detecto It is also effective as a broad range fre quency analyzer, and as a frequency moni tor in field applications.

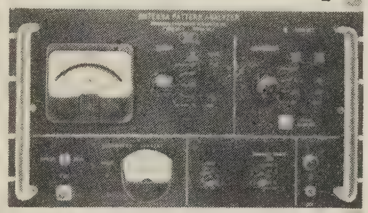
Crystal Video Receiver, a manuall tuned microwave receiver of moderat sensitivity and high selectivity. A com

WEINSCHEL
ANTENNA PATTERN ANALYZER MODEL BA-7

Measure 45 db (r. f.) in one step using a maximum of 1 microwatt r. f. power*

*100% square wave modulated at 1000 cps ± .1 cps. Observation time approximately 45 seconds for 45 db; only .2 seconds for 30 db.

Bandwidth variable from 2 to 15 cps with constant gain



MODEL BA-7

The BA-7 is the heart of a video detector system designed primarily for r. f. crystals. For greater versatility, a d. c. biasing circuit is included to permit use of conventional barretters, requiring a d. c. bias between 0 and 10 ma. The unit can be used to measure very high power ratios such as occur in making antenna pattern measurements, to determine the rejection coefficients of r. f. filters, and to calibrate attenuators. It has a wide dynamic linear range, a low noise level, and a wide r. f. frequency range where video crystal mounts are available.

For complete specifications, write for Bulletin No. 141.

Weinschel Fixed Coaxial Attenuators cover the frequency range of DC to 12.4 KMC. Write for complete catalog, specifying frequency range of interest

WECO

Weinschel Engineering
KENSINGTON, MARYLAND

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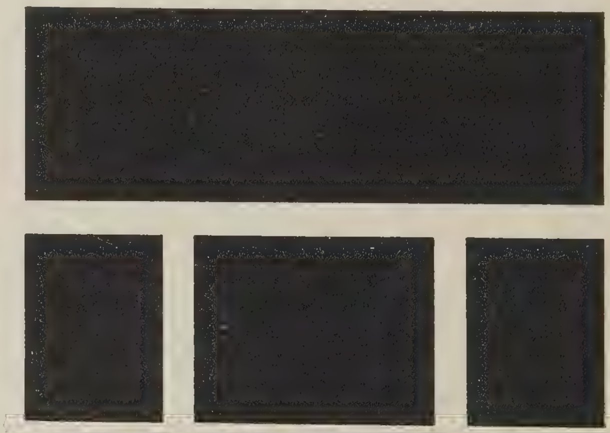
STAMP OF APPROVAL

When you see the double-T it means the product you've just received is certified FREE of both mechanical and electrical imperfection. This we guarantee. It's one of the reasons we say, Trans-Tech "foremost in ferrites"—polycrystalline, garnets and precision grinding, too.



TRANS-TECH
foremost in ferrites
ROCKVILLE, MARYLAND

Represented Nationally by: J. E. Hachten Co., San Gabriel, California • Industrial Equipment, Inc., Washington, D. C. • P. J. Engineering Sales Co., Watertown, Mass. • Mr. Frank Hayes, 618 Syracuse Ave., Massapequa, N. Y. • Vanguard Associates, Inc., Melbourne, Florida and Atlanta, Georgia • Lloyd F. Murphy and Associates, Inc., Minneapolis, Minn.

Circle Reader Service Card 63

low-cost unit ($950), it is especial- eful in the laboratory or for field rements of radar and communi- ns systems.

e instrument has a sensitivity of dbw (minimum) and a selectivity per cent at 3 db. Its video band- is 4 mc and its frequency ranges ctave and waveguide bands from 1 kmc.

ystal Modulator, Model X-154, produces amplitude modulation of e wide frequency ranges.

low, 3-volt maximum modulation l permits amplitude modulation of F signal within its frequency range cess of 10 db dynamic range with- requency modulation.

itchable Circulator, which replaces entional circulator permanent mag- with electro-magnets, permitting l electronic switching of a receiver een an antenna and a calibrated source. The output of the receiver then be synchronously demodulated when the calibrated noise level ls the signal from the antenna, the nna noise level is read directly off oise source dial.

ircle Reader Service Card 152

—mwj—

LEVINTHAL ELECTRONIC PRODUCTS
BOOTH 824

vinthal Electronic Products, Palo , Cal., a subsidiary of Radiation Inc., bourne, Fla., and a Western Elec- ic Manufacturers Association mem- company, will exhibit in Booth 824 Vescon, 1960.

ocation of the booth has been chosen e in a contiguous grouping with the bit of John Francis O'Halloran & ciates, the company's field engineer- and sales representatives in the areas California, Arizona, and Nevada.

roducts on display will be entirely re- d to the company's specialty of re- ch, development, and manufacture of smitters, modulators, power supplies, accessories for radar, communica- s, telemetry, control, and electron- e development. Since these activities olve mainly large equipment of mega- t capabilities in the microwave re- n, derivative details and general in- nation will actually be on display.

Complete finished products from the gnetic-component department will be view, such as high-power pulse trans- ners and related items.

Levinthal personnel in attendance at booth will include: Dr. Elliott C. inthal, president, and Albert J. Mor- senior vice president, engineering, ounders of the organization; and Ro- t V. Johnson, manager, applications ineering.

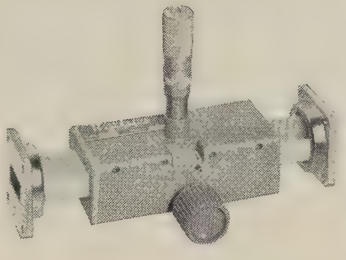
Circle Reader Service Card 153

(*Continued on page 96*)

—mwj—

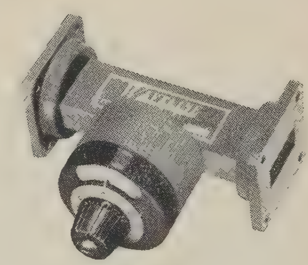
NEW!

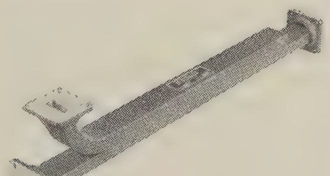
PRECISION WR-51 TEST EQUIPMENT



- PRECISION COUPLERS
- TERMINATIONS
  - High Power
  - Low Power
  - Sliding
- ADJUSTABLE SHORTS
- TRANSITIONS
- SHORTING SWITCHES
- CRYSTAL MOUNTS
- SLOTTED LINES

- ATTENUATORS
  - Flap
  - Variable
  - Precision
  - Direct Reading
  - Fixed Pad
- ELBOWS and TWISTS
- PRESSURE UNITS
- BULKHEAD FLANGES





- VARIABLE SCREW TUNERS
- FREQUENCY METERS
- TEES
  - Shunt
  - Series
  - Magic

Our WR-51 Test Equipment brochure is available on request.

WAVELINE INC.
CALDWELL, NEW JERSEY
CApitol 6-9100
TWX Caldwell, N. J. 703

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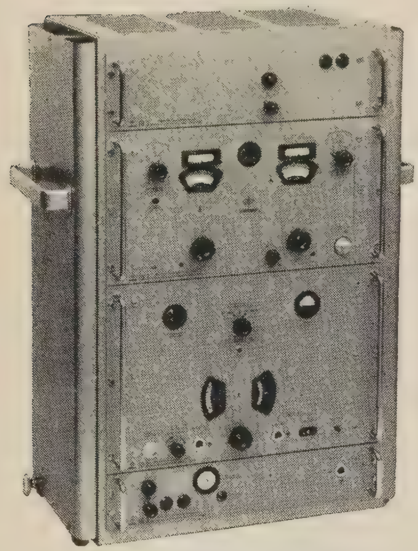
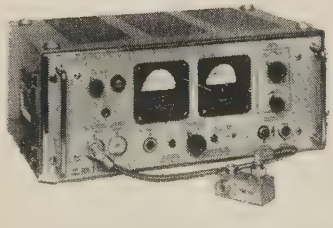
$F = f_{\text{Klystron}} \pm 10\,\text{Mc}_{\text{Syn}}$

The FD 3 Microwave-Frequency Decade by Schomandl KG (Munich) brings frequency synthesis to a new high of versatility, simplicity and dependability. The FDS 3 Syncriminator phase-locks klystrons and carcinotrons to reference standards. Discriminator IF constantly compared to a 10-Mc standard. With Schomandl Decade Synthesizers, kilocycle and hundred-cycle increments can be made in the kMc region. Video readout for lock evaluation. Data sheets on FD 3 and FDS 3 Microwave Decades from Electronic Applications, Inc., Stamford, Connecticut.





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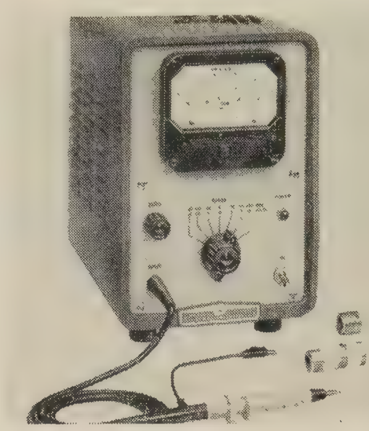
Wescon News

(Continued from page 95)

HEWLETT-PACKARD,

BOOTHS 651-654



Model 411A Voltmeter

A newly-designed 10 to 1000 mc oscilloscope and a 1000 mc, one millivolt voltmeter are among the new electronic measuring instruments to be introduced by Hewlett-Packard Co. at the 1960 Wescon Show.

The Hewlett-Packard exhibit will include more than 15 major instruments and accessory devices. These will be arranged in actual test setups to demonstrate the speed, convenience and accuracy provided by modern instrumentation.

The Hewlett-Packard equipment will be exhibited at booths 651, 652, 653 and 654.

Among the new instruments to be introduced by the company are:

Model 185A Oscilloscope which has a new, improved probe design, and is now usable up to 1000 mc. Pulse display is clear and steady anywhere in the 10 to 1000 mc range. The scope has full 10 cm vertical deflection and dual channel input for waveform and time comparisons.

The instrument provides fast sweep speeds to 0.1 nanosecond / cm. A highly sensitive oscilloscope, it also offers versatile sweep expansion for extreme resolving capability, a flexible input with five modes of operation, and a sync pulse output for triggering external circuits. Response is flat within 3 db to at least 800 mc.

Model 411A Voltmeter which has a voltage range of one millionvolt to 10 volts. It measures small voltages to 1000 mc with the convenience and accuracy associated with audio-frequency measurement.

Primary Frequency/Time Standard System which provides a compact, convenient primary frequency and time standard, and includes four new instruments: Model 113AR Frequency Divider and Clock, Model 103AR Frequency Standard Model 724AR Standby Power Supply, and the Model 120AR Oscilloscope, which is used as the indicator.

Model 525C Frequency Conve which increases the measuring capabi of Hewlett-Packard counters to 500

Model 170A Oscilloscope, a rugg militarized 30 mc scope with maxim reliability and versatility.

Model 160B Oscilloscope, a rugg 15 mc general-purpose scope built MIL standards. Among the plug-in u it accepts is the new Model 166C I play Scanner, which provides autom permanent recording of a CRT trace.

Model 722A Transistorized Power S ply, a compact unit supplying fully re lated dc output voltages to 60 volts .2 amps. It has a three-terminal out so that either positive or negative minal may be grounded.

Model 682A Sweep Oscillator, a c venient and flexible instrument for taining cw and swept RF frequenc 1 to 2 kmc. Model 682A maintains c put flat to within ±1 db.

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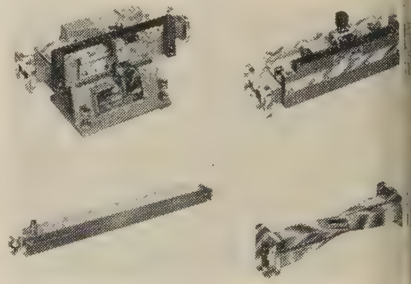
— mwj —

NARDA MICROWAVE CORPORATION

Booths 822-823



Among the products shown at the 19 Wescon Show by the Narda Microwa Corp., Mineola, L. I., N. Y., will be t following:

A new line of measurement equipme and components for D9 double ridg waveguide systems in the 4.75 kmc to 11 kmc band. The line includes an impedan meter, a slide-screw tuner, a direction coupler, and a 90 degree axial twist.

A line of Klystron tube mounts design for safety and convenience in testing a operating Klystron tubes. Models are ava able for use with Varian, Sperry, Raythe and EMI Klystron tubes.

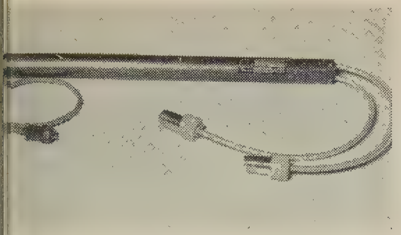
Narda's new high power microwave mo ulator, Model 10002, which is designe to accommodate any of 76 magnetrons, co ering 5400 mc to 35,000 mc with pea outputs from 20 kw to 500 kw.

Circle Reader Service Card 155

— mwj —

HUGGINS LABORATORIES

BOOTHS 820-821



An addition to the Huggins line of veling wave tubes which will be wn at the 1960 Wescon Show is the -70 which operates with an extremely noise factor in the 1 to 5 mw power ge. The HA-70 is focused in a 750 uss Solenoid. It has a noise figure of db maximum, 25 db gain minimum, mw saturation power output min, quency range of 2300 to 3400 mc, minimum of 70 db back attenuation.

The tube is 22.4 inches in length and inch in diameter. Warranted for 0 hours, the HA-70 has lasted in ual performance in many cases three to r times this period.

ircle Reader Service Card 156

—mwj—

LITTON INDUSTRIES

Booths 2101-2104, 2065-2068

even divisions of Litton Industries, verly Hills, Calif., will show products, eral of them for the first time, at Wescon.

Divisions participating in the exhibit in oths 2101-2104 and 2065-2068, which ll be adjacent to the registration area of show will be:

Electronic Equipments, Electron Tube, estrex Corp., Airtron, Inc., Triad Trans mer Corp., U. S. Engineering Co., and tentiometer.

Litton's Electronic Equipments Division ll have an exhibit pointing up the capa ities in inertial guidance, computers and hnical systems.

A new klystron, developed and produced the Electron Tube Division, will be wn at Wescon. The San Carlos plant o will show magnetrons, backward wave illators, a new, 40-inch traveling wave e and miniature gas noise sources.

Printapix, the new direct writing cathode tube, will be shown on the West Coast the first time by the division.

Dr. Norman H. Moore, Litton vice-presi nt and general manager of the Electron be Division, and John McCullough, will at the show.

Westrex will present new products in the borne miniature tape recorder and tape der. Magnetic heads also will be shown. o Call, sales supervisor of the Recording uipment Department of Westrex, will be the exhibit.

Airtron will show a wide range of dummy loads, microwave switches, ferrite components, waveguides (both flexible and rigid), mixers and duplicators and precision castings. The exhibit will be manned by Dick Olsen, sales manager, Airtron-Pacific, and Robert C. Kolts, marketing manager, from the Morris Plains, N.J., Airtron office.

A general line of electronic transformers, including military, audio, choke, filament, transistor, toroidal and TV replacement types will be shown by Triad and also will feature a new line of transistor transformers and of micro-miniature transformers under the name, "Red-Spec."

Lew Howard, vice-president of Litton and president of Triad, will be present at the display.

USECO will show electronic hardware, anodized aluminum knobs and handles, terminals, terminal strips and precision plated circuits. Jack T. Gentry, general manager of USECO, and Paul Robichaud, sales manager, will be at the exhibit.

A variety of potentiometers will be displayed by the Potentiometer Division. The division will be represented by James Weidenman, general manager.

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—mwj—

(*Continued on page 99*)

MICROWAVE TUBE ENGINEERS

B.S. to Ph.D.

interested in research development or manufacturing are offered a stimulating atmosphere at Hughes Microwave Tube Division in Los Angeles.

Areas of specialization include:

- high-powered periodically-focused travelling-wave amplifiers
- lightweight low noise amplifiers for broad band receivers
- low drainage satellite communication tubes
- multielement phased array amplifiers

Responsibility is limited only by ability. For additional information or to arrange an interview appointment, please write, wire or call collect: Mr. Don MacDowell, ORchard 0-1515, Extension 5792.

HUGHES

MICROWAVE TUBE DIVISION

HUGHES AIRCRAFT CO

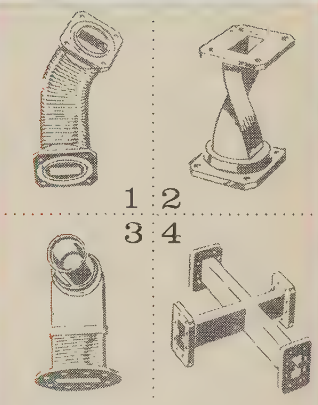
11105 ANZA, LOS ANGELES 45, CALIFORNIA

MICROWAVE

BUILDING BLOCKS FOR THE SPACE AGE

by

ELECTRONIC SPECIALTY CO.



1 **FLEX WAVEGUIDE ASSEMBLIES**
Electrical Characteristics
Operation .... 12.4 to 18.0 kmc
Attenuation .... 0.16 db/ft.
VSWR .... 1.08 max.
Bend Radius
E Plane ..... 5/16 inch; 5/8 with jacket
H Plane ....1/2 inch; 1.0 with jacket
Mates .... RG - 91/U
Weight .... 1.002 lbs./Ft. (bare)
Operating Pressure ..... 30 PSIG max.
Equivalent
Flanges .... Plate (UG-419/U)
Choke (UG-5 A/U
Other Standard Sizes Available

2 **RIGID WAVEGUIDE ASSEMBLIES**
ID Size Range .....From 0.420 x 0.170 to 6.50 x 3.250
Frequency .... From 1.12 to 26.5 kmc
Rigid Waveguide assemblies are furnished either straight or in a variety of configurations, including system plumbing.

3 **WAVEGUIDE TO COAX TRANSITION**
Frequency Range ... 2350 to 3600 mc
Power .... 800 watts cw
VSWR .... <1.2:1
Insertion Loss .... <0.25 db
Coaxial Impedance ...... 50 ± 2 Ohms

4 **POWER DIVIDERS**
Frequency Range .... 4.7 to 11.0 kmc
VSWR 1.4:1
Power
Split ..... +0.5 db (4.7 to 11.0 kmc)
Power .... 400 watts average
Altitude .... >60,000 feet
Meets MIL-E 5272-A and MIL-E-5400

ES development engineers welcome the opportunity to furnish an engineering estimate on your specific requirement. Emergency circumstances given special consideration. Ask for the TECHNICRAFT design folder.

TECHNICRAFT
DIVISION
ELECTRONIC SPECIALTY CO.

CORPORATE OFFICES:
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Los Angeles 39, California
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SYLVANIA

SPECIAL TUBE OPERATIONS

(San Francisco Peninsula)

Needs three inventive engineers to contribute to advanced development programs in

- Ferrite Components
- Klystrons

Unusual opportunities to influence Sylvania's microwave components expansion program.

For further information contact Dr. R. G. E. Hutter

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Subsidiary of General Telephone and Electronics
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M S FLANGES

IN STOCK

THE FINEST QUALITY BRASS AND ALUMINUM STANDARD WAVEGUIDE FLANGES in stock at Formcraft—all precision made to military standards. For rigid and flexible waveguides.

Special flanges to your specifications. Send sketch or blueprint for a quotation.

SEND FOR NEW BROCHURE #14B DESCRIBING AND ILLUSTRATING ALL THE STOCK FLANGES

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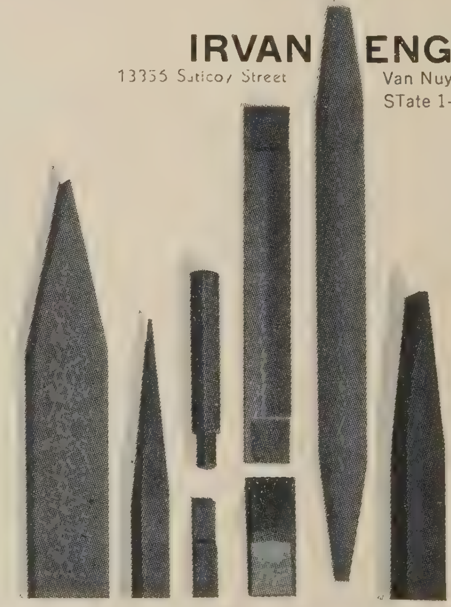
IF YOU DEPEND ON FERRITES
...YOU DEPEND ON IRVAN

from microwave to recording head frequencies, Irvan has a national reputation for superior performance. Irvan has the most complete and up-to-date facilities in the country for ultrasonic, surface, centerless, OD and ID grinding and has on hand over 30 grades of ferrite material for "yesterday" delivery on your ferrite orders.

IRVAN ENGINEERIN

13355 Saticoy Street
Van Nuys, California
STate 1-2620



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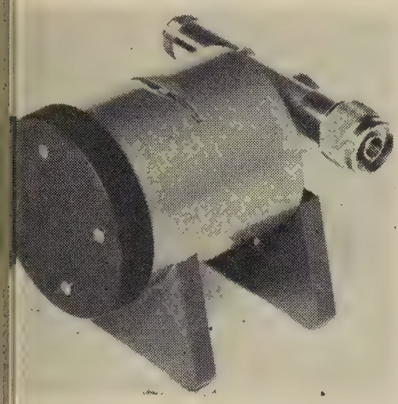
(*Continued from page 97*)

FXR, INC.



FXR, Inc., Woodside, N.Y., manufactur- of microwave and electronic equipment, ll display the direct reading coaxial fre- ncy meter, Model N414A, at Wescon 60.

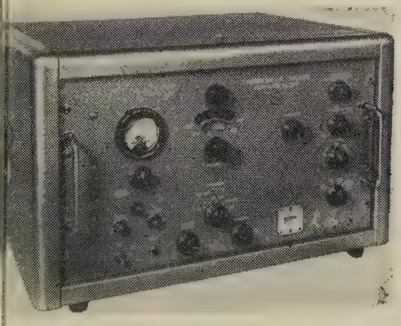
A coverage of over three waveguide ds, from 3.95 to 11 kmc, extends its fulness for either coaxial line or wave- de setups and makes it a fitting compan- to FXR's Model N410A direct reading uency meter, whose range is 1.00 to 4 . Like its predecessor, its absolute ac- cy is 0.10 per cent.

The FXR Model N414A direct reading quency meter is a reaction type instru- nt, absorbing power only at the resonant quency of a half wavelength resonant ity. The mirror-finished cavity surface silver plated and rhodium flashed. The ing plunger is a noncontacting choke e with a high resonant Q.

Backlash has been eliminated in the in- ument's drive mechanism and smooth op- tion is further assured by supporting the ing-loaded drive on a precision ball bear- g.

An applicable FXR Series 601 waveguide- coax adapter permits the use of the instru- nt, with its Type N connectors, in H-,C-, - or X-Band waveguide setups.

Also displayed at Wescon will be a sweep nal source with agc which provides a ans of measuring the reflection coefficient microwave components by direct oscillo- pe presentations.



The RF power source of the instrument is an electronically-swept permanent magnet type bwo tube. A built-in agc amplifier can be used with an external detector to provide an almost flat reference source (±1/2db) over the frequency range from 8.2 to 12.4 kmc. In this manner reflectometer measurements can be made without the use of a ratio meter.

Direct reading dial settings are provided for both the upper and lower frequencies of the swept range. Dial accuracy is ± 1 per cent. RF sweep is linear with respect to the time base. Output power is adjustable continuously from 0 to 20 mw, minimum, and the resolution or sweep rate is adjustable continuously from 0.3 to 300 kmc/sec.

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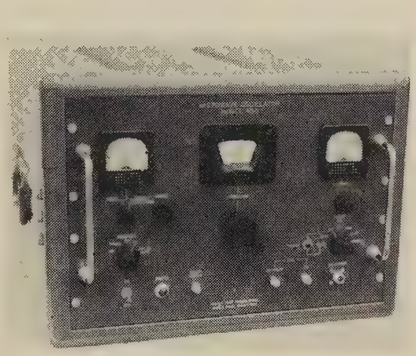
—*mwj*—

MENLO PARK ENGINEERING
BOOTH 835



Menlo Park Engineering, Menlo Park, Cal., will demonstrate the Model 944 Constant Power Microwave Signal Source at the 1960 Wescon Show.

Model 944 is the latest addition to the MPE product line of microwave instrumentation. Designed for operational ease and versatility, this instrument provides the development and production engineer with a convenient tool for rapid response analysis of both active and passive microwave networks and devices. The 944 consists of the Model 450 microwave oscillator and the series 500 microwave power level used together as a system.

Features of the system include swept frequency operation up to 100 cycles per second over the 8.2 to 11.0 kmc range. Output power capability is 10 dbm minimum with total power variation less than ± db for all conditions of operation.

Other products to be displayed by Menlo Park Engineering include a permanent magnet focused traveling wave tube amplifier, Model TA-36, operating in the UHF band with 30 db gain and 10 dbm output power, and the low noise microwave amplifier, Model TA-23, operating in X-band with a noise figure of 11 db.

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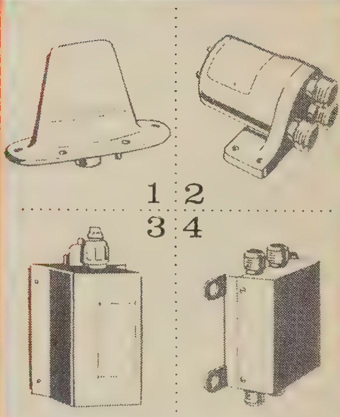
IFF/TACAN

BUILDING BLOCKS FOR THE SPACE AGE
by
ELECTRONIC SPECIALTY CO.



1 **L-BAND ANTENNA LB-247** — Designed for F-104

Range	960 to 1220 mc
VSWR	<1.7:1
Power	2 kw (peak)
Polarization	vertical
Qualification	MIL-A-25708
Weight	< 8 Oz.

2 **MINIATURE CO-AXIAL SWITCH CS-319**

Power Handling	200 W cw - 3 kw peak @ 0.1% duty cycle
RF Voltage	1000 min.
Operating Voltage	18 - 30 vdc
VSWR	1.2:1 max. to 1250 mc
Insertion Loss	0.2 db max.
Isolation	40 db down to 1250 mc
Qualification	MIL-S-25878

3 **ANTENNA SELECTOR RY-472G**

Switching Rate	70 ± 15 cpm
Life	>500 Hours
Input Power	24-29 vdc
Output Power	2 amp. ind. @ 28 vdc
Power Consumption	7 watts max.
Qualified	MIL-E-5272
Weight	3 lbs. max.

4 **DIPLEX FILTER DP-318**

Frequency	950 to 1215 mc
Filter Characteristics per Air Force Requirement	F-339/A MIL-F-25880
VSWR	<1.4:1
R F Power	2 kw peak; 2 watts average
Weight	3.0 lbs.

ES development engineers welcome the opportunity to furnish an engineering estimate on your specific requirement. Emergency circumstances given special consideration. Ask for the RADIATING SYSTEMS design folder.

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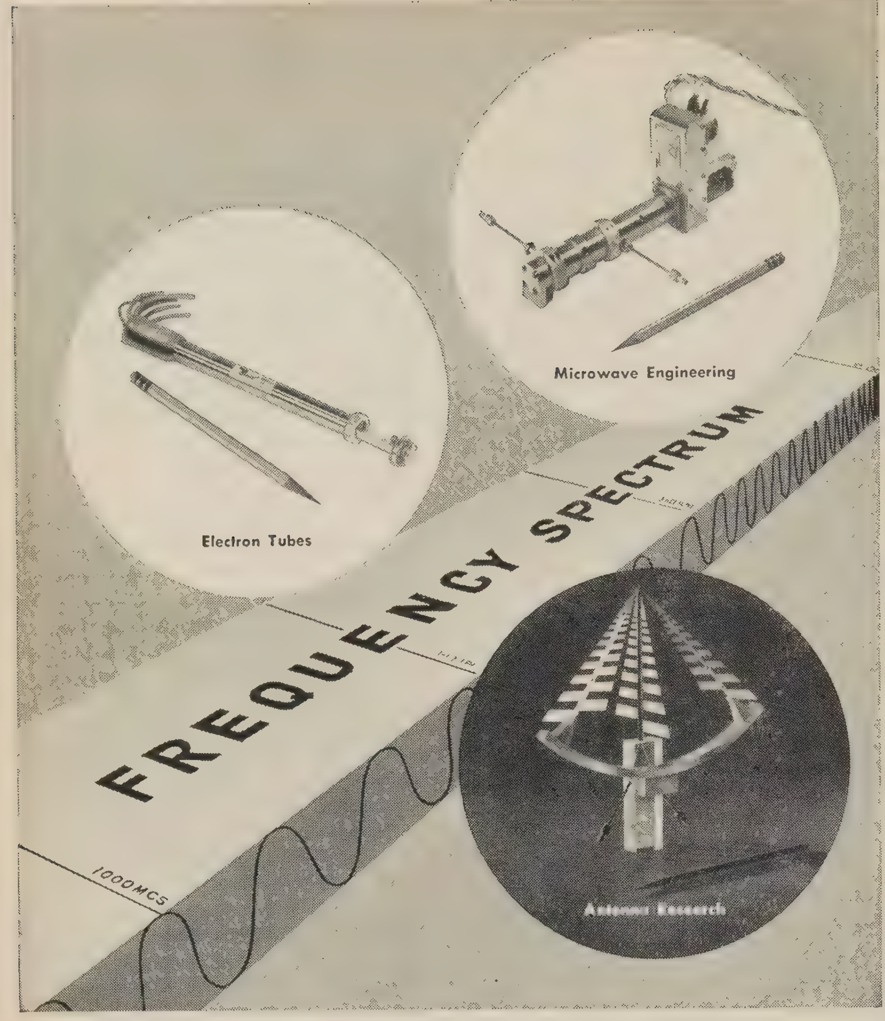

OPPORTUNITIES IN UHF AND MICROWAVE RESEARCH AND DEVELOPMENT

Never before has such high priority been given to microwave research and development . . . never before have the opportunities been so great in this field for the qualified engineer and scientist.

The Research Center of The Bendix Corporation—The RESEARCH LABORATORIES DIVISION—is expanding its programs in the UHF and microwave field to create interesting and challenging positions for qualified personnel.

Technical openings are now available in the following fields:

ANTENNA RESEARCH in electronic scanning, log periodic antennas, microwave optics.

MICROWAVE ENGINEERING—in ferrite devices, electronically controlled phase shifters, parametric amplifiers.

ELECTRON TUBE research in BWO and TWT from 1,000 to 150,000 mcs.

Investigate these opportunities *now*, where your technical competence and potentialities will receive full recognition in "Building Your Future with Bendix".

**If interested, please write or wire A. Capsalis,
Research Laboratories Division, The Bendix Corporation,
P.O. Box 5115, Detroit 35, Michigan.**

Research Laboratories Division
SOUTHFIELD, MICHIGAN

THE Bendix CORPORATION

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MA

Electro-Mechanical Microwave Design Engineer

R&D group requires
MECHANICAL ENGINEER
familiar with
microwave systems or components
to assume complete responsibility
for the mechanical design
of unique
microwave component devices
and mechanical layout
of complex systems.

Opportunity to work with a team of highly skilled electronic engineers. This position offers an attractive salary for a qualified engineer and unusual growth potential.

**Contact Dr. Kornreich
at BRowning 2-3000
or visit our personnel office.**

MICROWAVE ASSOCIATES, INC.
BURLINGTON, MASSACHUSETTS

MA

EW LITERATURE

EW BULLETIN BY WAVEGUIDE, INC.

New Bulletin describes the X-Band veguide Switch manufactured by veguide, Inc., Costa Mesa, Calif. The itch is a precision built single pole, uble throw, manually operated device igned for laboratory use. It permits venient switching from a slotted line a reflectometer, or for readily switch- from one signal source to an alter- e source for gain measurements. The itch facilitates and also speeds tests ile cutting down on set-up time. Full cifications are contained in the bulle- .

Circle Reader Service Card 160

— *mwj* —

POWER SUPPLY CATALOG

A new catalog describing the com- ny's line of high voltage power sup- es is announced by The Victoreen In- ument Co., Cleveland, Ohio.

The eight page, two color bulletin tures main components in the broad ge of single and dual units for opera- n up to 5000 v. The bulletin des- bes each in detail, gives suggested plications, and lists detailed specifica- n data for easy selection of correct it.

Copies of Form 3114-9 "Victoreen gh Voltage Power Supplies" are avail- le on request.

Circle Reader Service Card 161

— *mwj* —

BROCHURE AVAILABLE AMERICAN ELECTRONICS' INSTRUMENT DIVISION

A new four page, two color brochure, Meeting The Challenge", has been issued the Instrument Division, American Elec- nics, Inc., Culver City, Calif., according Jerry Yablonka, Division General Man- er.

The new brochure outlines the capabili- s of the Instrument Division in the devel- pment and packaging of electronic, electro- echanical and mechanical subsystems for ntrol systems in missile, space and air- aft vehicles.

Copies of the brochure are available, with- t charge.

Circle Reader Service Card 162

— *mwj* —

HEWLETT-PACKARD INDEX OF APPLICATION NOTES

In response to numerous requests, Hew- tt-Packard Co., Palo Alto, Calif., has repared a complete Index of some 40 Ap- lication Notes issued by the Company over he past several months.

The Index presents a useful abstract of each of the Company's Application Notes. These notes cover a variety of subjects of interest to users of electronic measuring instruments. They describe electronic theory, measurements, and applications of —hp— instruments. Typical topics covered are traveling wave amplifiers, solid state devices, masers; various frequency, microwave and current measurements; and applications of oscilloscopes and oscillators. A recent note, for example, describes techniques employed for microwave standards measurements, while another discusses calibration procedures for several instruments commonly used in standards laboratories.

A brief study of the Hewlett-Packard Index will enable the reader to select those Application Notes of particular interest to him. He can then obtain the notes by writing the company or the local —hp— engineering representative and requesting them by number and title.

Circle Reader Service Card 163

— *mwj* —

FOLDING, MOBILE TRACKING ANTENNA DATA

Specifications and detailed information, including antenna pattern data just taken, are reported on a two page bulletin issued by D. S. Kennedy Co., Cohasset, Mass., which describes the recently announced mobile tracking antenna system. The antenna features a folding 28 foot reflector, tilting mast, which lowers into the self-contained trailer, and hand-operated azimuth and elevation drive.

Circle Reader Service Card 164

— *mwj* —

GE POWER TUBE BULLETIN

Bulletin PT-35, 24 pages, published by the General Electric Power Tube Department, Schenectady, N.Y., contains detailed information on application and operating characteristics of the GL-6283 metal-ceramic tetrode for military and UHF uses. Tube features long life and reliability, has full power output to 900 mc, 300 watt useful CW power and 100 watt linear AM output at 400 mc.

Bulletin also includes complete technical data on four other power tetrodes which can be used in conjunction with the GL-6283.

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— *mwj* —

(*Continued on page 102*)

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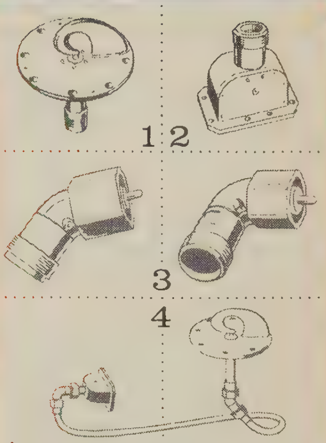

1 **SCIMITAR ANTENNA ABS—S—653**
Frequency .... 2350-5000 mc
VSWR .... <1.15:1
Efficiency .... >95%
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An extremely efficient device designed with very low VSWR. Frequency band from 2350 to 3600 mc. Manufactured in one piece as a solid light weight casting. Features high power (800 watts cw) with low insertion loss (<0.25 db.)

3 **ADAPTERS (45° & 90°) ADC—657 ADC -656**
These adapters are designed for high power applications. *The one piece solid light weight casting provides weight savings. A special slip nut permits fast installation. The dielectric is a solid injection mold.
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New Literature

(*Continued from page 101*)

GENERAL RADIO RANDOM-NOIS GENERATOR BROCHURE

An illustrated four page brochure de cribing the Type 1390-B Random-Nois Generator has been released by the General Radio Company, West Concor Mass.

Highlights of the circular are a basi schematic of the instrument, curves comparing the amplitude distribution of random noise with that encountered in active communication systems, and the amplitude-frequency characteristic of th noise generator.

Typical measurement setups are als shown, with a comprehensive list of typ cal applications in electrical and acoustical measurements, environmental testing and statistical investigations.

Detailed, too, are electrical, electroni and mechanical specifications of the generator.

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—*mwj*—

NEW GREIBACH BULLETIN EXPLAINS NO-FRICTION METER MOVEMENT

Overload protection to 125,000,000 pe cent without impairment, sensitivities to 0.2 microamp full scale and better than 1/4 per cent accuracy are among the unique meter characteristics made possible by the Greibach Bifilar movement, which is explained in detail in a new bulletin just issued by Greibach Instruments Corp. New Rochelle, N. Y.

The patented movement is used in the company's wide range of single and multi-range (to 23) current, voltage and resistance meters, in bench, panel and portable models.

Enlarged views reveal how the Bifilar design, using no pivots, jewels, hairsprings or amplifiers, is permanently calibrated, requires no tapping or re-zeroing, and provides readings with no parallax from any angle. Inherently rugged, the Biflar suspension movement can withstand more than 500 G's shock.

As shown in schematics, lowest millivolt drop and lowest resistance are achieved by eliminating the universal shunt across the entire meter coil. The insertion loss is thus reduced to near the vanishing point, permitting direct hypercritical measurements. Lowest energy consumption, to at little as $4x10^{-10}$ watts full, is about 1/300th of conventional meter movements.

Electrical measurement of transistors semiconductors, amplifiers and ionization are among the applications suggestions given for the many types of meters listed available in individualized range combinations to meet specific requirements.

Copies of the new Greibach Bulletin as well as the complete 20-page Greibach Catalog are available on request.

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WESCON

1960

ROBERT C. HANSEN
Associate Editor
the microwave journal

By this time, Wescon is again upon us, this time in Los Angeles. It, like the New York convention, has a new home, the Sports Arena, site of such diverse activities as basketball and the Democratic Convention. It has always seemed to me that this convention has a unique flavor not shared by the larger International Convention nor by the regional and specialized shows. Somehow Wescon has seemed more like a show of which the engineer feels a part, while at other shows he feels more like a spectator. However, in spite of its home-grown flavor, Wescon has a considerable amount of professional polish.

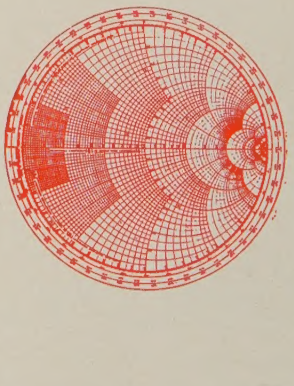
Since many readers have never had the pleasure (and strain) of working on a large convention, I'll try to give you a behind-the-scenes look at this one. Wescon is "run" by an eight-man board of directors, four representing WEMA, the Western Electronic Manufacturers Association, and four representing the IRE. Two from each group of four are from the San Francisco area, with the others from the Los Angeles area. As the site for Wescon alternates between San Francisco and Los Angeles, the four IRE men represent the host IRE sections. A complicated arrangement of overlapping four-year terms for the directors assures continuity. The board of directors is backed up by Business Manager Don Larson and a modest but highly competent staff, with headquarters in Los Angeles, and by a very large corps of volunteers. All the work of planning and operating the convention is done by these volunteers, with guidance from the business office and the help of movers, decorators, electricians, etc. Usually the personnel of each committee serves only one year, and I believe that it is this constant infusion of new blood and new ideas that gives Wescon its pleasant atmosphere.

The committees are 14 in number, each with a chai man and vice chairman. These are as follows: technic program, field trips, future engineers show, registratio visitors' services (housing), facilities, hospitality (VIP's all-industry luncheon, all-industry cocktail party, exhibit industrial design exhibit, public relations, women's a tivities, and the distributors conference.

Before the end of 1959, the technical program commi tee is at work, planning the program format and puttin out paper calls. Most other committees are organized i full by February 1. Some committees such as future e gineers, luncheon, and field trips begin their duties i early months, setting up procedures and filling out the program needs. Then follows a lull during which commi tee members get re-acquainted with their families; th period is abruptly shattered by the coming of Augu when events rise to a fevered pitch. Activities of othe committees such as facilities and hospitality are relativel peaceful until shortly before the convention. Then th committee ranks swell enormously to handle the wor during the convention. Still other committees such a public relations are busy all throughout the months, grinding out news of the affair.

One of the things that makes the news is a continuin stream of innovations at Wescon. These include publishin a booklet on giving talks (for speakers), setting up com mentary panels at many sessions, providing conventio papers at the time of the convention and reducing the siz of the convention to raise quality and keep things 'in hand.' Perhaps this last factor is most important of all There seems to be a sort of critical size for each type o convention, analogous to critical mass. A certain size mus be reached to attract enough men in each field to mak attendance worthwhile. This is due to the fact that many of us feel that discussing problems with contemporarie is just as important as hearing papers and seeing the latest gadgets. If the convention grows much beyond thi size, the engineer is likely to be swamped by the immensity of not only the trade show but of the technica sessions as well.

Well, it will be a time for meeting old friends; discussing the state of the art; making new friends; doing the town; seeing the latest components, techniques, and equipments; hearing and discussing recent advances in electronics; and just plain enjoying a change from our regular routine! See you there!



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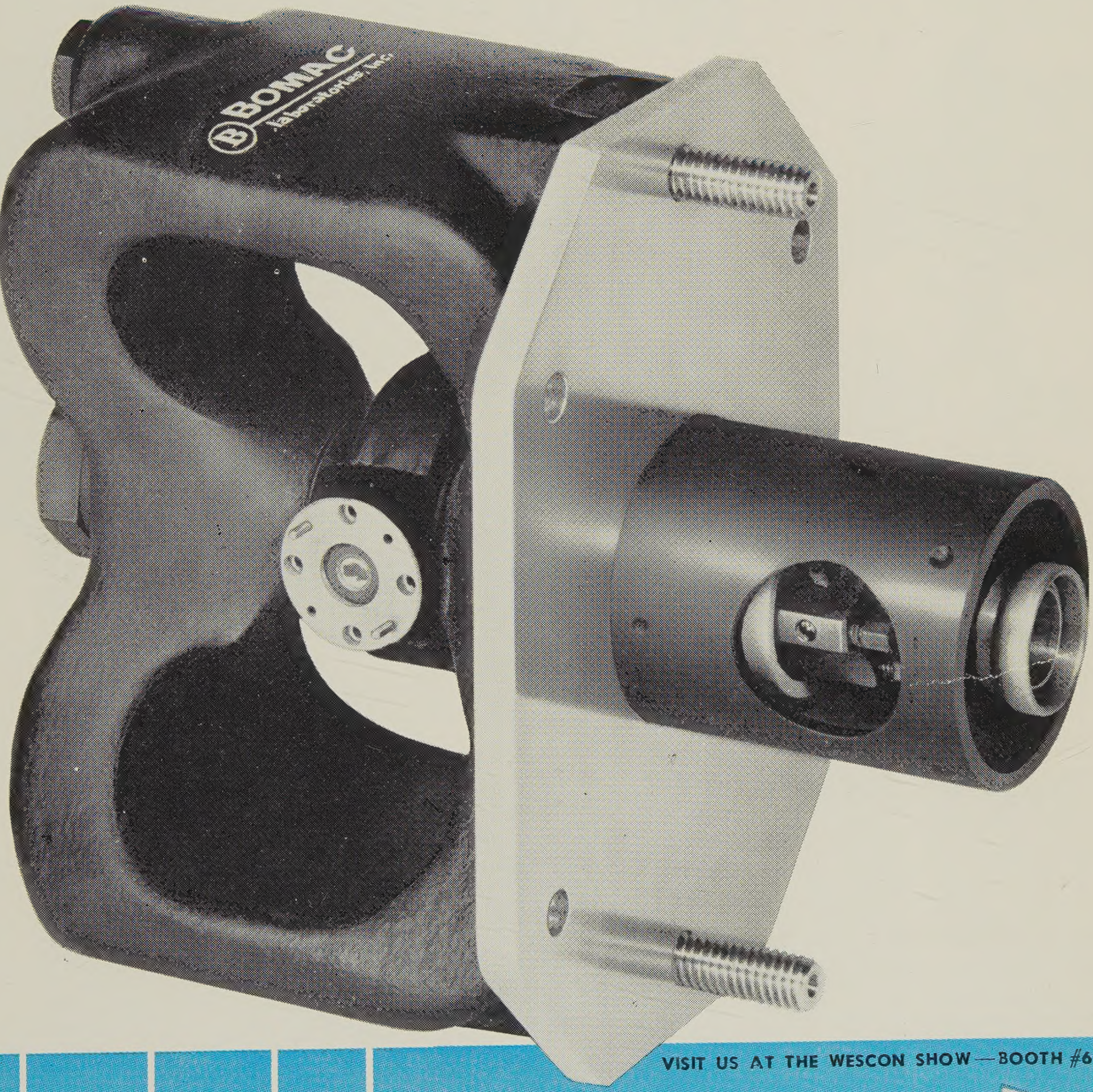

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V	BL-236	54,000–57,000	10	UG385/U
V	BL-237	57,000–60,000	10	UG385/U
V	BL-221	69,000–70,500	10	UG385/U

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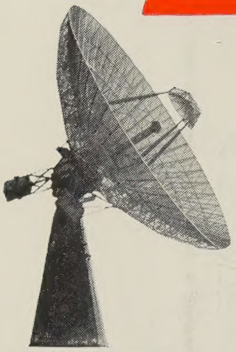

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